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PRACTICAL COURSE FOR APPRENTICES

Details of a new, practical system of instruction for boys who wish to excel in foundry work, patternmaking or machine shop practice

THE industrial and educational world is familiar with the co-operative courses in engineering established at the University of Cincinnati by Prof. Herman Schneider, and the tremendous success which this scheme of education has achieved is a matter of common knowledge. There is now being offered by the Lewis Institute, Chicago, a co-operative course for shop apprentices which is the result of two years careful experiment and embodies many advanced ideas in industrial education. In accordance with the plan adopted at the Cincinnati University, the boys in the new course at Lewis Institute work in pairs; one spends his time in some regular commercial shop, while the other receives instruction at school and at the end of each week they change places. But at this point the similarity between the two systems of instruction ceases.

Courses Compared.

At the University of Cincinnati the courses follow the regular technical routine leading to engineering degrees and a high school education or its equivalent is required for admission. At Lewis Institute the work is arranged for shop apprentices who intend to remain in the shop as expert workmen, foremen or superintendents after their school days are over and who do not intend to become engineers; no special preliminary training or educational qualifications are required for admission. In short, the Lewis Institute co-operative course aims to supply a greatly needed link in our industrial training system, by furnishing the widely demanded general and specific instruction required by ambitious workmen who wish to

FIG. 1—A CORNER IN THE FOUNDRY OF THE LEWIS INSTITUTE, CHICAGO

FIG. 2—A CORNER IN THE PATTERN SHOP OF THE LEWIS INSTITUTE

excel in their trade and make the shop the scene of their careers. The course is expected to go a long way toward providing the breadth of knowledge and experience necessary to successfully fill the position of foreman or superintendent. To a certain extent, at least, it is hoped the training given will so fit young men with natural executive ability that, with a little additional practical experience, they can meet the widespread demand for capable foundry foremen.

For the present the courses will be confined to the engineering trades, special attention being given to foundry practice, patternmaking and machine shop work.

Work of the Lewis Institute.

Lewis Institute is situated in the heart of the manufacturing district of Chicago. It is primarily a school of mechanic arts and engineering, its purpose being to provide such technical training as underlies a large number of occupations in which skill and intelligence are demanded. It aims to raise the worker's scale of wages, to improve his standard of living and to enlarge his field of usefulness by placing within his reach opportunities for advancement suited to his capacity and needs. The school, it is thus seen, is intensely practical.

The new co-operative course for shop apprentices is the outgrowth of considerable study and experiment. In the spring of 1908 the Chicago branch of the National Metal Trades Association appointed a committee on industrial education of which the following were members: John B. Hibbard, F. S. North, John W. O'Leary, H. E. Goodman and P. W. Gates. This committee met with George N. Carman, director of Lewis Institute, and worked out a scheme for training apprentices for the mechanical trades. As a result of this work a plan of co-operation between certain shops in Chicago and Lewis Institute was decided upon.

Boys Who Take the Course.

It was thought that the boys most likely to take advantage of this course would be, first, those who were working in shops either as apprentices or employes; second, boys, who from necessity or choice, had left school to go to work and had drifted into occupations that did not offer opportunities for advancement, and third, boys in school who were either unable to continue without financial assistance or who were dissatisfied with the kind of training they were receiving and would welcome an opportunity to work at some mechanical trade a part of the time and still continue in school.

It was the opinion of the committee that a large majority of these boys would be unable to make the sacrifice in wages or give the time from their apprenticeship period that a long course would demand. Accordingly, a two-year course was decided upon, with alternate weeks in school and shop. Each class is divided into two sections and the boys pair off, thus insuring a constant employe at the shop and uniform classes at school. The boys are paid by their employers

FIG. 4—A CLASS IN MECHANICAL DRAWING

FIG. 3—MACHINE SKETCHING AND STUDY OF PATTERNS

for their shop work in accordance with a scale which is given subsequently. The plan calls for 26 weeks in the shop, 22 weeks in school and four weeks vacation each year.

In offering this course it is not the idea of the manufacturers concerned or of the institute that the students will become skilled workmen in two years, but work in the shop combined with instruction in the school will give them a much more intelligent idea of their trades than they could otherwise obtain.

Any boy between 16 and 21 years of age who can satisfy his employer that he is capable of doing the work in the shop and satisfy the institute that he is prepared to profit by the instruction is eligible to take the course. No formal examination is required.

The tuition for the two years of co-operative work is $100, divided into quarterly payments. Boys who are unable to meet this expense, but who do satisfactory work during their first term are relieved from paying tuition through the operation of the Noyes scholarships, as will be explained later in this article.

FIG. 6—THE ELECTRICAL LABORATORY, SHOWING THE STUDENTS TESTING MOTORS

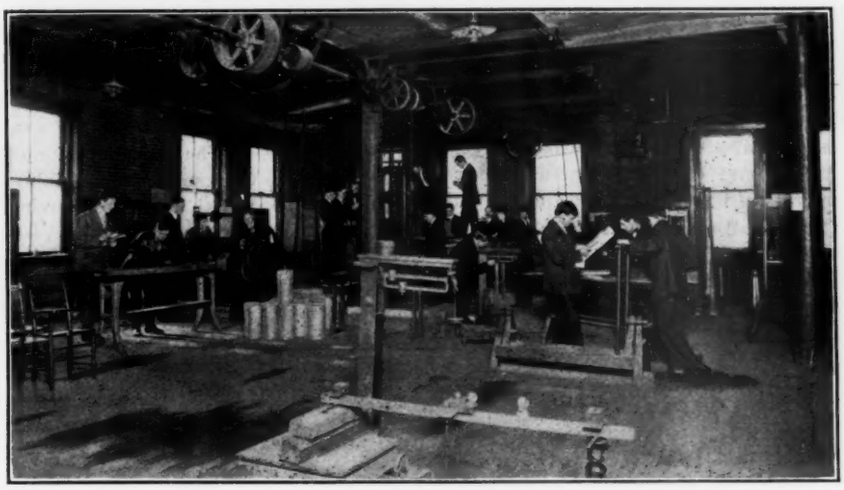


FIG. 5—MECHANICAL LABORATORY; TESTING THE STRENGTH OF MATERIALS

The questions now arise, what kind of boys take advantage of this course, just what training do they receive in school and in the shop, where do they go and what are they good for when they graduate?

In December, 1910, 20 boys completed the two years' work out of 47 starting, for it will be remembered the work has been tried out experimentally a sufficient length of time to graduate one class. Of the 47 starting, 14 were already working in the various co-operating shops and 33 were recommended by the institute. Their average age at entrance was 18 years and one month. Seven had attended one year at high school, two had only completed the sixth grade, while a number had been out of school several years. These were slow getting on at first and were inclined to be discouraged, but after a few months they made rapid progress and at the end of the course seemed to have as comprehensive an understanding of the subjects covered as did those who had the advantage of several more years' schooling.

In the various shops in which the boys are employed they are placed side by side with the regular workmen and are given such tasks as their experience and capacity permit. It is the aim, however, of the various co-operating manufacturers to give the boys as wide and varied a line of work as possible without interfering with the regular manufacturing operations. While in the shop the boys conform to the same hours, rules and other conditions surrounding the regular employes. In short, while they are in the shop they are an integral part of its organization, and the discipline and knowledge of shop administration thus obtained is invaluable.

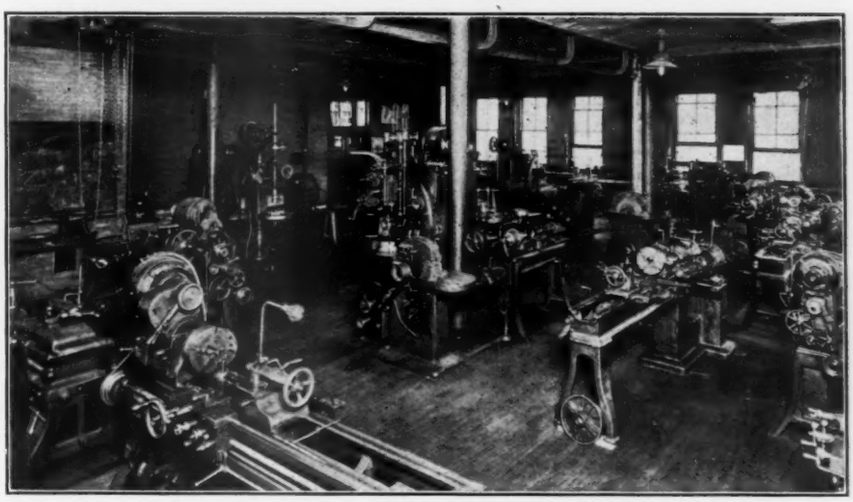


FIG. 7—MACHINE SHOP AT THE LEWIS INSTITUTE; ALL OF THE MACHINE TOOLS ARE DRIVEN BY INDIVIDUAL MOTORS

As suggested, these boys are not being trained to be engineers, but to become foremen or shop executives and their training in the various manufacturing plants is consequently more detailed.

Instruction in Foundry Work.

Those who elect to specialize in foundry work are, in the course of the two years, given a chance to learn the details of both hand and machine-molding, core room practice and patternmaking. A special effort is being made to interest as many of the co-operative students as possible in foundry work on account of the exceptional opportunities in this field and the great demand for skilled, capable foundry executives.

For his shop work the boy is paid according to the following scale:

	Cents an hour for all shop time.
First six months	12
Second six months	13
Third six months	14
Fourth six months	15

As there are some employers who prefer to pay the boys for all the time whether they are in the shop or in the school, the following equivalent scale is used:

	Cents an hour for all school and shop time.
First six months	6½
Second six months	7½
Third six months	8½
Fourth six months	9½

During the year the employers as well as the superintendents and foremen of the shops in which the boys are employed, visit the classes at the institute and make helpful suggestions. Once a year the boys, their employers and instructors get together for an annual dinner. Addresses are made by a number of employers and occasionally by outside engineers.

Firms Co-Operating.

Up to the present time 27 firms, including many of the most prominent manufacturers in Chicago, have made arrangements to co-operate with the Lewis Institute in this work. These include the Acme Steel Goods Co., Aermotor Co., Allis-Chalmers Co., Benjamin Electric Mfg. Co., Borland-Grannis Co., H. W. Caldwell & Son Co., A. Finkel & Sons Co., E. Goldman & Co., Goodman Mfg. Co., Gregory Electric Co., Hanna Engineering Works, W. S. Jones Foundry & Machine Co., Kroeschell Bros. Co., Latham Machinery Co., Link Belt Co., Mehle Printing Press & Mfg. Co., Pelouze Electric Heater Co., Roth Bros. & Co., Simonds Mfg. Co., Sullivan Machinery Co., Temple Pump Co., Thordarson Electric Mfg. Co., Union Special Machine Co., Weir & Craig Mfg. Co., Weller Mfg. Co., Fred W. Wolf Co., and Wood Motor Vehicle Co.

Noyes Scholarships.

In December, 1909, La Verne W. Noyes, who had a number of co-operative students in the shops of the Aermotor Co., Chicago, learned that there were many deserving boys who were anxious to take the course, but who were unable to pay the tuition out of the small wages earned. Realizing that the course would fail of its purpose unless it was possible for these boys to take full advantage of it, Mr. Noyes generously offered to pay the tuition of all co-operative students who should do earnest work in both school and shop. He has thus showed his appreciation of what has been done and has made it possible for boys to become competent workmen, who otherwise might have been obliged to do work which would qualify them for nothing in particular and which would offer no opportunities for advancement. Mr. Noyes has agreed to offer these scholarships to the aggregate of $10,000 a year. At the end of each term all the co-operative boys employed in the mechanical trades who present a card signed both by their employers and instructor in charge stating that they have done satisfactory work, are given a scholarship which entitles them to a term's tuition.

Subjects Taught.

During the winter the school sessions extend from 8:40 a. m. to 5 p. m. and in the summer from 8:10 a. m. to 4. p. m. In the two years' course, instruction is given on 14 different subjects, of which the most important are shop mathematics, machine sketching, machine shop, foundry and pattern shop practice, mechanical drawing and shop organization. The work in drawing is designed to familiarize the student with drawings and to enable him to read them quickly and accurately, rather than to make him a draughtsman. The course in shop mathematics is planned to give a ready command of the principles of mathematics in dealing with problems which arise in shops and factories. The importance of short methods and common sense checks is emphasized and as far as possible the memorizing of rules and processes is avoided.

Lewis Institute has a very completely equipped machine shop, in which the co-operative students are taught the principles employed in the various processes used in modern machine tool operations. The construction and methods of manipulation of the different machines are explained and the mechanisms used by different builders of similar tools to obtain speed and feed changes are examined and described. Special study is made of cutting tools with reference particularly to heat treatment and proper grinding. Practice is also given in the operation of the various common machine tools, including plain and differential indexing on the milling machine. The instruction in the operation of the machines is largely individual and the work done depends entirely on the ability of the student.

The School Foundry.

The foundry at Lewis Institute is completely equipped with modern appliances for instruction in hand and machine-molding, coremaking and bench work. In the course of his work in the institute foundry, the student learns the various practical details of foundry operation, special attention being devoted to a study of cupola mixtures and the making of high grade machine castings of gray iron and brass. The institute foundry is conducted very much as a jobbing foundry and the students are required to work in all departments. Visits are also made to both light and heavy jobbing foundries and also to a number of factory foundries in the city of Chicago. These visits are a very important part of the course and the students are required to make written reports of them. Lectures are given on the location, arrangement and equipment of foundries, as well as on the materials used in making molds and castings.

The work in the pattern shop correlates the instruction given in the foundry and is designed to familiarize the student with working drawings from which patterns are made and to give practice in the care and uses of hand tools and patternmaking machinery. A special study is made of the methods of joining woods to prevent warping and exercises are given in planning and laying-out work and in the construction of typical patterns and core boxes, designed to demonstrate some principle and requirement necessary in the production of castings in the foundry.

In the forge shop the end sought is to impart a knowledge of the proper working of steel of different grades, also something about proper methods of heat treatment and above all, how to build a fire in a common forge and keep it under control.

One of the facts which has been prominently brought to light in connection with the experiments already made in co-operative education at Lewis Institute is the surprising amount of ground covered and work actually accomplished by the boys who are alternately in school and in the shop. It has been found that the co-operative boys cover as much ground in school as those who are in attendance constantly. This is due partially to the fact that vacations are shorter, but also because during the week they are in the shop the students have a chance to digest and assimilate the instruction which they received in the school during the previous week. Their progress is, therefore, rapid and steady.

Results Obtained.

In regard to the results achieved by this scheme of education, a few statistics regarding the class of 1910 will be interesting. In December, 1910, 20 boys completed the two years' work and at the commencement exercises in June, 1911, 17 who had satisfactorily completed the course of study were given school certificates. Six months after the completion of the course 14 of the 17 were still in the employ of firms with whom they had worked while students and the other three had been given the choice of remaining in active shop work, but were advised to find work where there were larger opportunities. The shop superintendents and employers who have had experience with the co-operative boys are a unit in strongly recommending the course of training which they receive. In one case an employer stated that some of the boys would be capable of acting as foremen in a small shop within a year after their graduation. At all events there can be no doubt that the efforts which Lewis Institute and the employers of Chicago are making in co-operative education marks a great step in advance of the methods of training shop apprentices.

The Development of Machine-Molding

AN EXHAUSTIVE treatise on "Machine-Molding," prepared by Wilfred Lewis of the Tabor Mfg. Co., Philadelphia, at the request of the Franklin Institute of that city, traces the development of molding machines from the first invention of the crude foundry labor-saving device to the highly perfected machines in use at the present time. This lecture was also delivered before the New England Foundrymen's Association at the Columbia University, the Annapolis Naval Academy and before the Worcester Polytechnic Alumni Association. The early development of the molding machine is discussed as follows:

"Although modern industry depends upon the foundry for a large part of its products and the ingenuity of inventors has been busily engaged for generations in the evolution of labor-saving machinery, very little of this effort has been devoted to the improvement of the foundry itself and it is only within comparatively recent years that machine-molding has developed much importance as an art. In the year 1800, an English patent was granted for molding screws, the patterns for which were backed out of the sand by lead screws of the same pitch. This was simply a pattern-drawing machine of rather ingenious construction, but the English records do not touch again upon machine-molding until 1839 when a very similar patent appears. From this time forward, more interest seems to have been aroused, and these patents were soon followed by others for packing sand by mechanical means, including hydraulic cylinders, stampers and rollers of the road-roller type. Machines for molding gears and pipes also appear in the first half of the nineteenth century and in 1843 we find an American patent on the molding of cannon balls. Later, in 1869, the first jarring machine patent was taken out, but I do not propose to give a history of the art of machine molding from patent office records and will simply point out that the art began in a small way on bench work and continued chiefly in its application to small molds that one or two men could handle, until the end of the last century. Larger work was not generally regarded as applicable to machine-molding until the jarring machine began to emerge from a long period of obscurity and demonstrate its peculiar fitness for ramming large bodies of sand. Its development for large work belongs mainly to the present century and through its means the art of machine-molding has been extended to embrace nearly everything molded in sand. There are, of course, exceptions and peculiar difficulties which will always depend upon the molder's skill for their proper execution, with or without the aid of machines, and like any other equipment, the installation of molding machines must depend upon the saving to be effected by their use and the outlay needed to effect that saving. This leads at once to the consideration of foundry costs, the analysis of which should point the way to their reduction."

Valuable advice is also contained in the paper for foundrymen contemplating the introduction of molding machines, which includes not only the making of observations in detail of the hand-molding methods in use, but also the recording of the time, by a stop watch, required for each and every step in the production of the mold. This phase of molding machine practice is discussed as follows:

"We are frequently asked to say what our machines will do and what production we will guarantee, regardless of the fact that we never know anything about the man behind the machine and seldom very much about the patterns to be used, the cores to be set or the precautions found necessary to insure success in molding the same patterns by hand. We know in a general way the type of machine required, but until we have actually made molds and poured castings, we are at a disadvantage and cannot safely guess at results which should be determined from a careful analysis of the experience gained in molding by hand. The foundryman contemplating the introduction of machines has had the necessary experience, but he seldom, if ever, has it in shape available for analysis, and I propose to show the importance of making observations in detail and recording the time required for each and every step taken in the production of a mold.

"Fig. 1 shows the result of observations taken on molding by hand by an experienced man with a stop watch. The time is taken in minutes and hundredths for convenience in summing-up. Items 4 to 11 inclusive have to be done in the same way and will consume the same time, 45 minutes, whether the mold is made by hand or by power, as will appear in Fig. 2; item 12 must be done more thoroughly and takes

more time when the mold is completed by hand; item 13 is not required for machine-molding; item 14, butt-ramming 0.30 is equivalent to squeezing by power, but it takes five times as long; item 15, striking-off, is performed after ramming and takes 0.03 longer than striking-off the unrammed sand on the machine; item 16 is not required in machine molding; item 17, rolling-over, is the same in both cases; items 18 and 19 take 0.14 minute and only 0.08 minute when compressed air is used on a power machine; items 20 and 21 are the same for hand or power-molding; item 22 shows 0.56 minute by hand against 0.18 by power; item 23 is not done by power as a separate operation; item 24 is the same in both cases; item 25, to rap pattern takes 0.48 minute against 0.12 minute to start vibrator and lift cope at one operation on machine; item 26 is the same in both cases; item 27, remove cope, takes 0.09 minute; item 28, blowing off pattern with bellows takes 0.04 longer than with compressed air; item 29, drawing pattern, takes 0.35 minute longer; item 30, patching, 0.30 minute, is not called for on machine; items 31, 32 and 33 are the same in both cases and in molding by power an additional operation, stopping-off carriers, 0.06 minute, is required.

Instruction Card for Operation.

Sheets, Sheet No. Drawing No. Hand molding. Order No.

Material. Class No. Pieces in Lot. Time for Lot. Bonus.

Description of Operation Molding Drag and Cope. (Part of Plow.)
Shown in Bulletin M R. January 1st, 1911. (Page 8.)
Flask 13″ x 17″. 4″ drag, 4½″ cope. Hand molding at bench.

Item.	Detailed Instructions.	Feed.	Speed.	Element time per piece—minutes.	Time for entire lot.	Continuous or running time.
1	Preparation.					
2						
3						
4	Pick up hard sand match and put on bench	..	..	0.04	..	..
5	Pick up pattern and put on hard sand match	..	..	0.04	..	..
6	Pick up drag and put in place	..	..	0.07	..	..
7	Shake parting on pattern	..	..	0.08	..	..
8	Pick up riddle and put on flask	..	..	0.02	..	..
9	Fill riddle with sand. One shovel full	..	..	0.04	..	..
10	Riddle sand on pattern	..	..	0.08	..	..
11	Fill drag with sand. Three shovels full	..	..	0.08	..	..
12	Pein around edge of drag and butt ram some (with shovel butt)	..	..	0.10	..	..
13	Put two more shovels full in drag	..	..	0.06	..	..
14	Butt ram	..	..	0.30	..	..
15	Strike mold off with bar ⅜ x 1 x 36″ long	..	..	0.10	..	..
16	Pick up bottom board and place in position	..	..	0.08	..	..
17	Roll mold over	..	..	0.08	..	..
18	Remove hard sand match	..	..	0.07	..	..
19	Blow sand off of mold (with bellows)	..	..	0.07	..	..
20	Repeat operations 6 to 10 inclusive for cope	..	..	0.29	..	..
21	Fill cope with sand, four shovels full	..	..	0.10	..	..
22	Repeat operations 12 to 15, inclusive, for cope	..	..	0.56	..	..
23	Mark sprue hole (with cope board)	..	..	0.05	..	..
24	Cut sprue hole	..	..	0.12	..	..
25	Rap pattern (spike going through sprue hole into pattern)	..	..	0.48	..	..
26	Round sprue	..	..	0.10	..	..
27	Remove cope mold	..	..	0.09	..	..
28	Blow pattern off with bellows	..	..	0.09	..	..
29	Draw pattern from mold by hand	..	..	0.45	..	..
30	Patch up mold (with slick)	..	..	0.30	..	..
31	Close mold	..	..	0.12	..	..
32	Remove snap flask from mold	..	..	0.07	..	..
33	Remove mold to floor	..	..	0.07	..	..
34				4.20		
35	Number 4 riddle.					
36						
37	Weight of shovel ..... 5 lbs.					
38	Weight of sand..... 16 lbs.					
	Total weight ..... 21 lbs.					

4 19 11 DVM.
Month. Day. Year. Signed.

Checked.

FIG. 1—TIME REQUIRED FOR VARIOUS OPERATIONS WHEN MOLDING PLOW CASTING BY HAND

Instruction Card for Operation.

Sheets, Sheet No. Drawing No. Machine No. Order No.

Material. Class No. Pieces in Lot. Time for Lot. Bonus.

Description of Operation Molding Drag and Cope. (Part of Plow.)
Shown in Bulletin M R. January 1st, 1911. (Page 8.)
Flask 13″ x 17″. 4″ drag, 4½″ cope. Power squeezer.

Item.	Detailed Instructions.	Feed.	Speed.	Element time per piece—minutes.	Time for entire lot.	Continuous or running time.
1	Preparation.					
2						
3						
4						
5	Pick up hard sand match and put on table of machine	..	..	0.04	..	..
6	Pick up pattern and put on hard sand match	..	..	0.04	..	..
7	Pick up drag and put in place	..	..	0.07	..	..
8	Shake parting on pattern	..	..	0.08	..	..
9	Pick up riddle and put on flask	..	..	0.02	..	..
10	Fill riddle with sand	..	..	0.04	..	..
11	Riddle sand on pattern	..	..	0.08	..	..
12	Fill up drag (three shovels full)	..	..	0.08	..	..
13	Pein around edge of drag (butt of shovel)	..	..	0.05	..	..
14	Strike off with board and put in place	..	..	0.07	..	..
15	Bring yoke over and squeeze 60 lbs. pressure	..	..	0.08	..	..
16	Roll mold over (on table)	..	..	0.08	..	..
17	Start vibrator and remove hard match	..	..	0.05	..	..
18	Blow off with compressed air	..	..	0.05	..	..
19	Repeat operations from 7 to 11, inclusive, for cope	..	..	0.29	..	..
20	Fill up cope (four shovels)	..	..	0.10	..	..
21	Repeat operations 13, 14 and 15 for cope	..	..	0.18	..	..
22	Remove cope board	..	..	0.03	..	..
23	Blow mold off with compressed air	..	..	0.05	..	..
24	Cut sprue hole	..	..	0.08	..	..
25	Start vibrator and lift cope	..	..	0.12	..	..
26	Blow mold off with compressed air	..	..	0.05	..	..
27	Start vibrator and draw pattern	..	..	0.10	..	..
28	Close mold	..	..	0.12	..	..
29	Remove flask	..	..	0.07	..	..
30	Stop off carrier	..	..	0.06	..	..
31	Place mold on floor	..	..	0.06	..	..
32				2.10		
33						
34	Number 4 riddle.					
35						
36	Weight of shovel..... 5 lbs.					
37	Weight of sand..... 16 lbs.					
38	Total weight ..... 21 lbs.					

4 20 11 DVM.
Month. Day. Year. Signed.

Checked.

FIG. 2—TIME REQUIRED FOR VARIOUS OPERATIONS WHEN MOLDING THE SAME PLOW CASTING WITH A POWER SQUEEZER

"Fig. 2 shows the operations in detail for molding the same pattern on the machine. There are 30 opera-

tions by hand, footing-up 4.20 minutes and 27 operations on the machine footing-up 2.10 minutes, making the machine time just one-half of the time required when molding by hand without the use of compressed air.

"It is also apparent from a study of these time tables that the use of compressed air alone instead of bellows will effect a saving and that the vibrator in connection with hand molding will also effect a greater saving. Making the necessary substitution in Fig. 1 for the use of blower and vibrator it will be found that this additional equipment alone would reduce the molding time from 4.20 to 3.06 minutes. It, therefore, appears that the blower and vibrator can be used to save 1.14 minutes per mold and the squeezer, 0.96 minute more. This looks as though the blower and vibrator alone saved so much that it might not be worth while to put in the machine, but if we look again at the increased production, taking hand work as the basis for comparison, we see that the output from the use of the former is $\frac{4.20}{3.06}$, or 1.38, while from the use of the latter it is $\frac{4.20}{2.10} = 2$, that is an increase of only 38 per cent on hand work against 100 per cent on machine work.

"It may be argued, however, that another element of time remains to be considered, and it may be admitted that no account has yet been taken of the time required to distribute a large number of molds on the floor. I do not know how far a mold can be carried and placed on the floor in 0.06 minute, the time noted, but this time should be taken to about the middle of the space to be covered, and perhaps some additional time should be allowed for this item, but on the other hand, it may be said that no allowance has been made for the inexperience of the operator, who was in this case a pattern fitter, and not a molder or demonstrator. The time given will vary with different men and it was taken in these cases simply for the purpose of illustrating the method by which important conclusions can be reached. No better data can be obtained for fixing prices and when time is taken by an observer of experience, who understands his business, the stop watch never runs unless useful work is being done in the right way. A reasonable allowance should always be made for contingencies and a bonus put upon the performance of the work specified in the allotted time."

Latter-Day Pattern Shop Practice--III*

By W. S. Giele.

THE manufacture of valves would seem to offer an almost ideal field for machine molding, not only on account of the comparatively large number of castings of one kind, particularly in the smaller sizes of standard types, but also on account of the symmetry of the designs. The great majority of valve parts are symmetrical about a plane and are, therefore, perfectly adapted to mounting on flat plates for squeezer machines where the same plate makes both cope and drag. This arrangement involves but half the pattern equipment and half the number of pattern changes on the machines used where two plates are necessary and when machines are not run in pairs and permits the closing of the molds as rapidly as they are made.

*Presented at the Pittsburg convention of the American Foundrymen's Association.

Many of the small parts which are not symmetrical about a plane can still be made with a plane parting and on a single plate by mounting opposite halves of the pattern in such a position that they will come in the proper relation in the mold. This is accomplished by the well-known transfer plate process, which will be briefly described.

Transfer Plate Process.

Assuming a plane parting, half as many split patterns as there will be castings in the mold are made, the mating halves being marked for identification. The planed pattern plate is drilled for the flask pin holes by the standard drill jig. Each pattern is carefully matched and has two small holes drilled entirely through both halves. A plate, a little more than half the width of the pattern plate, is then prepared, either with two holes matching the flask pin holes or two other holes on the center line between the centers of the flask pin holes. If the latter is the case, then corresponding holes must be drilled in the pattern plate. This transfer plate is then laid on the pattern plate and doweled to it by the holes already referred to.

One-half of each of the patterns is arranged on the transfer plate and holes are drilled, passing the drill through the holes already in the pattern through the transfer plate and through

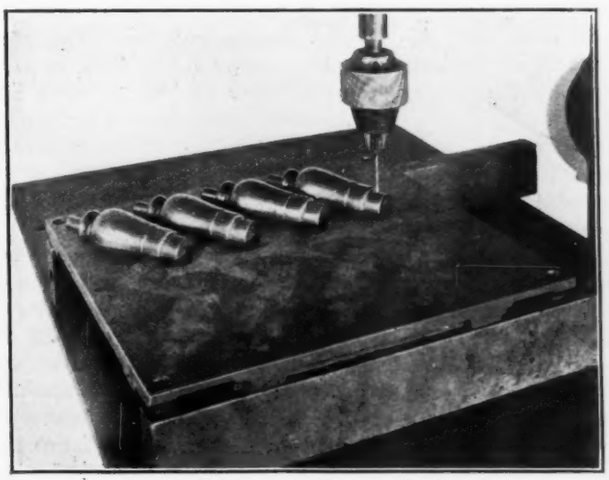


FIG. 1—DRILLING PATTERN PLATES FROM PATTERNS WHICH ARE NUMBERED

FIG. 2—DRILLING A TRANSFER PLATE FROM THE PATTERN PLATE. THE PATTERN PLATE IS ABOVE THE TRANSFER PLATE

the pattern plate. The transfer plate is then turned over exactly as the drag flask will be turned over in molding the job and located by its dowels. The other side of the pattern plate is drilled, using the transfer plate as a jig.

The half patterns used in drilling the plates are replaced on the plate and the mating halves, as indicated by the marks, placed on the other side of the plate, located by driving a snugly fitting rod through the drilled holes and screwed to the plates. The pattern halves must be turned just as the transfer plates are, that is, supposing a pattern to have a core print on one side and this core print is turned toward the runner in one-half of the patterns, then the core print must also be turned toward the runner in the other half of the same pattern.

If the drilling has been done substantially at right angles to the plane of the pattern plate and if the dowels and rod used have been a snug fit in the drilled holes the match will be perfect, provided, of course, that the flask pins and holes fit each other and those on the plate. The plates are usually iron, the pattern of iron, brass or alloy.

Making Gates and Bosses.

Gates and runners with feeding or shrinkage bosses, when necessary, are made of brass or white metal and are attached to the plates, as are also vents for the cores. This same practice holds good up to the point where a single half pattern is mounted on a plate, making both cope and drag of a symmetrical casting, one in a mold. Still larger patterns are made of wood and mounted on wood boards for jarring machines. The largest castings, such as large valve bodies, are made by hand from split wood patterns, and very large or special bodies occasionally from skeleton patterns.

The practice is to turn in the lathe, or otherwise accurately machine, every part that can possibly be machined, and to do this the master patterns may be divided into elements each turned separately and then the whole assembled into the complete pattern. This method also frequently obviates the trouble of working out difficult intersections.

Core Boxes.

Wood patterns and core boxes are made interchangeable for flanged, screwed and bell and spigot connections, but it is customary, when making metal patterns and core boxes, to make the master patterns interchangeable for the different types of connections, but to make separate metal patterns and core boxes for each type. Specials, such as bypasses, are made by attaching pieces to the standard patterns.

While the patterns for valves are comparatively simple, the core boxes are complicated. It is, therefore, natural to expect that many interesting methods, applicable to difficult cores in other castings than valve parts, have been developed. At the plant of the Nelson Valve Co., Philadelphia, it is the practice to separate these difficult cores into elements which not only facilitates the making of the core, but also the making of the box.

As in the case of patterns, the box is so divided into elements that all surfaces which it is possible to machine are so formed, hand work being confined to such irregular surfaces as the inside of the body. On the smaller cores particularly, it is the practice to make wood models of the cores, which is much easier to do and more accurate than working out the boxes for the cores. These wood models, with proper finish allowance for finishing up the box, are attached to boards, oiled and plaster casts made from them. These plaster casts, when sufficiently set, are worked down at the back to the proper thickness of metal, due provision for rapping bosses, pins and pin hole bosses being left. This work is greatly facilitated by band sawing the plaster cast to approximately the desired outline and working it down by hand.

The iron castings obtained from these plaster patterns require very little work to complete the core box, except that in the openings for pipe connections and seats, they are carefully turned on a lathe to insure the minimum of work in finishing the valve.

The larger core boxes, particularly in cases where new designs are being developed, are first made in wood in the usual manner, advantage being taken of the sectional element construction, the elements being shaped separately and assembled.

The iron boxes are subsequently made from these wood boxes by a very ingenious process. For the smaller core boxes a frame is made, the outside dimensions of which correspond to the outside dimensions of the wooden box, and inside this frame is placed a pattern of the same shape as the outside of the desired iron box. The wooden box is prepared for molding by pasting paper or other material for finish allowance on the joint surface and on other surfaces which are to be machined in the iron box.

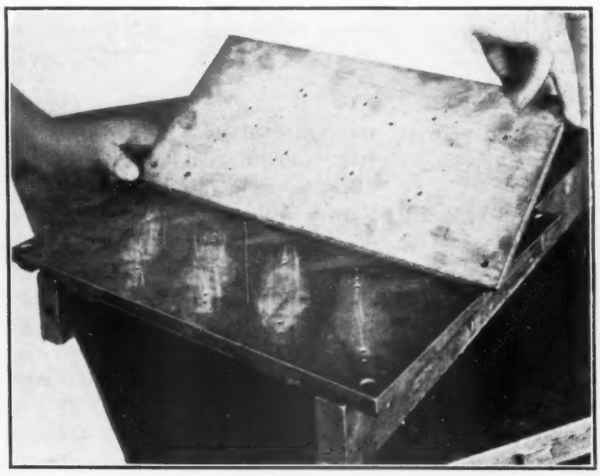


FIG. 3—TURNING THE TRANSFER PLATE

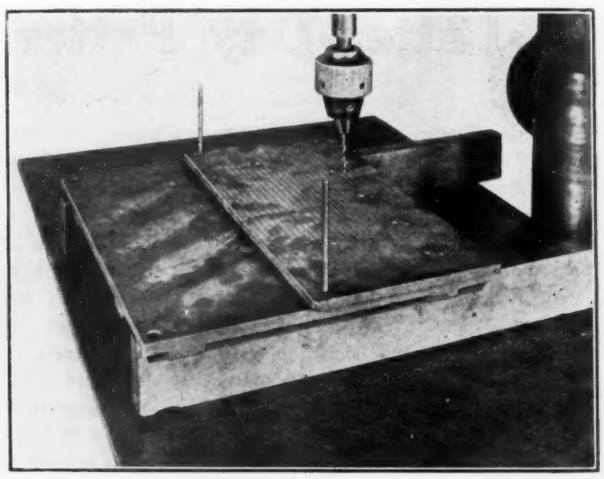


FIG. 4—DRILLING THE SECOND SIDE OF THE PATTERN PLATE

Large Core Boxes.

The wood box is then rammed up in a sand mold, as though it were a pattern, the inside of the box forming that portion of the mold which will form the inside of the iron box, the outside of the wooden box being practically a core print in this case. A dry sand core is made from the wooden frame containing a pattern of the desired shape of the outside of the iron box, previously referred to, and this dry sand

core is set in the impression in the mold left by the outside of the wooden box. Castings made in this way, accurately and cheaply reproduce the shape of the wooden box in the desired iron form.

In the case of larger boxes which it is desired to make of iron, the process is essentially similar except that in this case the pattern for the outside of the iron box is not made complete, but is made in skeleton and set into the frame, as previously described, the shape being formed in the core sand by strickles.

The chief difficulty in making valve cores arises from the diaphragms passing through the bodies of the cores and the collars and projections on these cores resulting from the raised seats and the tap clearance necessary. The diaphragms are almost universally handled by making them in the shape of loose pieces in the half boxes. The half cores with these loose pieces in place are rammed separately, struck off on the joint surface and the loose pieces withdrawn, after which paste is applied to the joint, the box assembled, rapped and drawn from the core.

Raised seats may be handled in the same way, that is, as loose pieces in the half boxes which are withdrawn before placing the half cores together. These seats can sometimes be made to draw directly from the half core boxes but usually must be rolled out.

Another expedient in making difficult core valve cores is a loose piece fitting each half box, on which are attached core prints. Separate dry sand cores are made and baked and dropped into the impressions left by these loose pieces, when the latter are withdrawn from the cores. In this case, also, paste is applied, after setting the inner core in the outer core, the box is assembled and withdrawn, leaving the core on the dryer with the inner core in place.

Still a third method is to divide the core into such parts as can be separately made in boxes, either with or without loose pieces, drying these core elements separately and assembling them afterward.

This process requires extremely careful work in the coremaking department to insure the parts of the assembled core being in proper alignment with each other. As far as possible, these core elements, which form openings in the valve which must be tapped in line with each other, are made in a single piece to insure the tapped openings being in line in the finished valve.

Prints.

Where it is not possible to carry a core element entirely through from side to side of the casting, the two ends may be located in the body core by means of long, tapered prints. These prints may either take the form of holes in the body core, corresponding to projections on the cores for the pipe openings or of projections on the body core, over which are placed cores in the shape of sleeves which form the opening in the casting to be tapped and the tap clearance.

Globe Valve Cores.

Globe valve cores are made in two parts, which are connected to each other through the hole in the seat. This is accomplished by providing a tapered, square plug on one portion of the core and a corresponding tapered, square hole on the other portion of the core. The taper is used for convenience in entering and to insure a tight fit after entering. The square is used to prevent the rotation of one core half with reference to the other half, such rotation resulting in the openings at opposite ends of the valve being out of alignment. It is needless to say that the core boxes for making these cores must be made with extreme accuracy.

The successful production of automobile cylinders is generally conceded to be one of the most difficult branches of the art of founding, on account of the intricacy of these comparatively light castings and the rigid inspection to which they are subjected. E. T. Doddridge, pattern expert with the Osborn Mfg. Co., Cleveland, was, for several years, in charge of the pattern equipment of the largest concern in the country engaged in the casting of automobile and gas engine cylinders.

The following is quoted from a letter written by him:

In the first place it is necessary to determine the method of making the casting to insure a clean and perfect section, true to the pattern. The usual practice and most successful on this class is making the casting on end, this being determined, however, by the style and general shape of the cylinder, as well as the convenience and safety in placing the cores and taking off the vents.

Parting lines are usually determined for the easiest and surest way of placing the cores in the mold and not, as in the case of most patterns, by the easiest way to make the mold. Any under-cuts, facings and core prints can then be taken care of by running extra core prints to the parting line in order to make the joint straight for ease in mounting the pattern on the molding machine, as nearly all such patterns are now made on machines.

Right here arises the question of the type of machine to use. As a general proposition, unless it is a four-barreled cylinder having a part of the crank case cast on, or an extra large one which would require several bars in both cope and drag, it has been the writer's experience that a machine of the flask-stripping type, or an ordinary stripping plate machine gives excellent results both as to speed and accuracy.

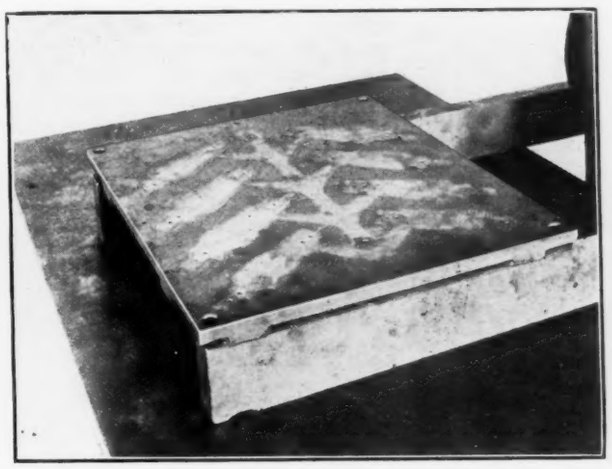


FIG. 5—PATTERN PLATE READY FOR PATTERNS, GATES AND RUNNER

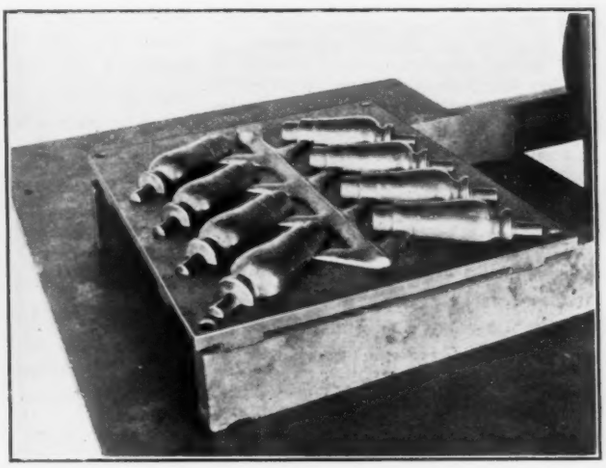


FIG. 6—PATTERNS, GATES AND RUNNER MOUNTED ON THE PATTERN PLATE

Sometimes, however, it is preferable to make the drag on a roll-over machine on account of not having to bar the drag flask, and the cope on a flask stripping machine. This method is usually the better one when the pattern used is a cylinder of the larger type and made in green sand. The core boxes should be carefully considered, not with the idea of making as few cores as possible, but making the cores accurately, easily assembled and pasted, as well as placed in the mold with the least trouble, always bearing in mind, however, that a good, clean casting is the desired end.

Flask Equipment.

The question of flasks is also very important, and the possibility of making standard flasks, pins, plate, etc., for this kind of work is important, and a little thought along this line will save a firm considerable money in the course of a few months, as the flask expense is usually one which is quite an item.

In making flasks for use on molding machines, accuracy in drilling the holes and fitting the pins is absolutely necessary, as well as having the flasks true on the joints. Poor results obtained from an otherwise perfect equipment will nearly always be traceable to imperfect flasks.

The question of pattern equipment is one of prime importance and usually a little time spent on a pattern, not merely to put a fine polish on it, but to make the pattern in such a way as to give the best results in the foundry and core room, will pay many times over, especially on duplicate work.

Shop Practice Compared.

In considering crank cases and similar castings so largely used in motor car construction, we have an interesting opportunity to compare the diverse solutions of the same problem developed in different shops. In a cast iron sanitary ware shop the pattern for a piece of this type has been observed made up complete in metal, follow-boarded, the whole mold being rammed up in green sand. Similar practice has been observed in stove shops on similar pieces, but in view of more recent developments in this line of work one would expect either a match-plate against one side of which the drag would be rammed and the opposite side of which would form the cope, or two mating match-plates, one for cope and one for drag, each backed with plaster or other composition for support.

In a motor car shop we find the drag pattern, plane parting in this case, fastened to a board against which the drag is rammed, corresponding to the match-plate referred to, but the cope instead of being rammed against a cope match-plate is rammed against a plane surface, the inner side of the casting being formed by a dry sand core hung from it.

The writer would not care to venture an opinion as to which of these three methods is the best, nor even to attempt the statement of a general rule which would define the circumstances under which any one should be given preference over the others. There are so many variables involved that each case must be decided on its own merits. In general, it will probably be conceded that either the follow-boarded pattern or the match-plate process would show a higher first cost for patterns than the dry sand core arrangement and offer less opportunity for changes in the pattern than the latter.

Low Pattern Cost.

Against the lower pattern cost we have the expense of making, drying, handling and setting the core. The follow-boarded pattern requires the handling of both follow-board and pattern and cannot conveniently be handled on the molding machine and is more liable to damage than either of the other two. The match-plate can be used with or without the machine. Whether made in one piece or as a pair it affords good protection to the pattern, the separate plate for cope and drag permitting the strongest possible support for the pattern surface. The latter construction often permits effective team work in the foundry, one man working on copes, the other on drags, and both together doing the lifting. This division of labor is practiced in both machine and hand molding.

The dry sand core method is perhaps to be preferred to the others where a small number of castings is required or where alterations may be necessary. Both pattern and core box can be made comparatively rigid of wood, thus permiting more rapid work in the pattern shop. The same division of labor in molding can be practiced with this equipment as with separate cope and drag match-plates.

Chain Sprockets.

The requirements of the Link Belt Engineering Co., Philadelphia, have been selected as a good example of a pattern equipment for this line of work, where a great variety of different size pieces, all of practically the same design, is required. This company's pattern equipment illustrates in a striking manner how standard pattern elements can be combined to meet the different requirements for castings and also where such combinations cannot be made to advantage. The sprocket patterns for the Ewart chain, which is the ordinary malleable cast link chain, sometimes referred to as chain belting, are made up complete in iron, as far as the teeth, rims and spokes are concerned. The spokes meet in a web at the center of the wheel, all wheels being bored at the center for a 1-inch dowel. All hub patterns are furnished with a 1-inch dowel pin, so that any hub can be used on any wheel pattern. The wheel patterns vary in diameter, in number of teeth and pitch of teeth.

The hubs are made to correspond to the diameter of the shaft on which they are to be used, the different pitches of chain and specifications for set screws or keys. Set screws and keys make it necessary to vary the amount of metal allowed in the hub for any particular size of bore. Thus, a sprocket of a given diameter and given bore would have a heavier hub for a large pitch chain than for a small pitch chain and a still heavier hub if a key-way is required.

None of these patterns is mounted for molding machine use, as it would not be possible to make up a stock of castings in advance, there being so many variables involved.

If a stock of castings, for instance, were made up for any given pitch and number of teeth, the hubs might not be of the right size, or if the hubs and pitch were right, the number of teeth might not be what was required.

A slight variation from these patterns is in those made for what is known as the "Flint rim" sprocket, in which case the pattern does not have the teeth, but a print around the edge which receives the chill for chilling the teeth and rim. This company has its patterns for cast tooth spur and bevel gears made up in the same way.

Interchangeable Hubs.

All the gear and sprocket patterns take two kinds of interchangeable hubs, the one for a solid wheel, the other for a split wheel, the split wheel hub pattern having prints for splitting cores and also for cores for the bolts by which the hub is bolted together. Where a wheel is made with the split hub, two lugs carrying a splitting core print and bolting core prints are fitted to the rim. In such cases, wooden patterns for tooth gears are used. The teeth are not dovetailed into the rim, but their position is indicated by center lines on the rim and on each individual tooth, the teeth being held in place by corrugated sheet metal fasteners driven half into the tooth and half into the rim. This makes a very much cheaper pattern than dovetailed teeth and it has been the experience of the Link Belt Co., that patterns, so made, are very satisfactory in service.

The usual finish allowance on the ends of the hubs for iron castings is $\frac{3}{16}$-inch, each end; $\frac{5}{16}$-inch is allowed for finish

in diameter of bore for hubs bored up to 2⅛ inches in diameter. For hubs bored larger than 2⅛ inches and up to 4⅛ inches, a ⅜-inch finish is allowed in the diameter, and for hubs bored larger than 4⅛ inches, ½-inch finish is allowed in the diameter.

In wheels to be cast in steel the finish allowance in the bore is never less than ½ inch in diameter and up to 2 inches bore the cores are omitted entirely.

Large diameter sheave wheels for rope drives are made from complete wood patterns, using a dry sand core for the groove in the rim wherever there is but a single groove. Where multiple grooves are required, it is customary to sweep the rim, using a hub pattern or hub core box and a core box containing a half arm, two cores being used to make each arm, and the hub and arm cores are assembled in the mold after the rim has been swept.

Spools for cable hauls, which have a neck in the center, smaller in diameter than the ends, are made by parting the pattern in the center and molding in a three-part flask, the center line of the casting being vertical in the mold.

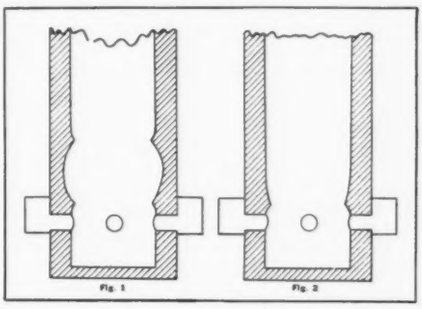
A rather unusual casting made by the Link Belt Co. for its coal-handling equipment, is a screw conveyor flight casting, consisting of a hub with part of a helix attached. As the helical portion of this pattern would not draw directly from the sand, the hub is made hollow in the pattern and the helix attached to it by thumb screws from the inside. When drawing the pattern from the mold, the thumb screws are removed and the helical portion of the pattern is screwed out of the mold. Another rather unusual casting is the drum for the coal crusher. These drums are made from solid, cylindrical patterns which, in effect, consist of a print for the chills, which form the outside of the casting, and prints for the cores which hollow out the inside of the casting. The chills form the teeth on the outside of the drum and are set in the impression left in the mold after withdrawing the pattern.

Shrinkage Difficulties

By N. W. Shed

Question:—We are experiencing considerable trouble in casting a pump runner designed in Germany, the original castings for which were made in that country. A number of foundries in various parts of the United States have attempted to make these runners, but with little success. The mold is made up of dry sand cores with a green sand cope. The castings shrink around the hubs and it seems as though the cores chill the iron so that it will not draw from the heads, notwithstanding the unreasonably large heads we are using. The iron mixture is the same as that used for ordinary machinery castings.

Answer:—The shrink holes at the corners on the cope side can usually be overcome by driving small nails or brads, about ½ inch apart, into the mold at the corners. The heads of the nails will cause the iron to chill at these points, thereby insuring a solid casting. The points of the nails are cut off after the casting is shaken out of the sand. This works well on small cylinder heads which are liable to be spongy at the corners. Another method would involve increasing the thickness of the metal at the collar and placing a tapering riser head on the cope side. This will insure a body of hot metal at the corners and the metal would remain fluid sufficiently long to feed back to the spongy parts. It would be better practice to make the



SECTION OF CUPOLA, SHOWING HOW THE LINING WAS BURNED OUT, AND THE PROPER METHOD OF LINING

cope, as well as the cores, of dry sand. This would keep the metal fluid longer at the top of the casting. As the section is very thin it should be poured from soft metal averaging from 2.50 to 2.80 per cent silicon and with a phosphorus content of over 0.70 per cent. The metal used for radiators would give good results in these thin castings. Many machinery castings do not contain more than 1.60 per cent silicon, which is too low for this class of work. By gating this casting on the top and by insuring a good flow of hot iron, you should experience no trouble in making these castings.

Cupola Melting Difficulties

By W. J. Keep

Question:—In Fig. 1 is shown a cross-section of our 24-inch cupola, which, after three or four heats, burns out, as indicated, to a diameter of about 28 inches and the lining in that condition lasts for from three to five months. The cupola is provided with four 3-inch tuyeres and the blast is furnished by a pressure blower. We use Connellsville coke and the bed extends two feet above the tuyeres. The iron charges consist of 200 pounds of 50 per cent scrap and 50 per cent pig metal. We melt from 2,000 to 2,600 pounds per heat. Although the iron is hot, the castings are exceedingly hard. We cast grate bars three in a flask and they frequently break in the sand.

Answer:—When relining a blast furnace, the new lining is made to conform to the shape of the old lining as closely as possible. A blast furnace lining cannot be repaired during the many months that the furnace is in operation and there may be local causes for the shape of the lining after a period of continued operation. A cupola is a small blast furnace and if after two or three heats the lining burns out to 28 inches, as shown in the cross-section, and then lasts from three to five months, it is evident that melting conditions cause the lining to shape itself this way. The next time you line your cupola, have it conform to the shape, to which it was burned out. As shown in Fig. 1, it is evident that just above the tuyeres the slag gathered until the diameter at that point was reduced to about 22 inches. When relining, build the brick out over the tuyeres an inch or so and then set back each course of brick a short distance for a height of two feet, until the lining reaches 28 inches inside diameter. From this point build it straight to the charging door. Cupola linings will occasionally burn out more in one place than another and holes in the lining should be patched each day. However, if you attempt to fill out that section of the lining burned away, as shown in Fig. 1, it would immediately flake off. In the cross-section of the cupola, shown in Fig. 2, the overhang above the tuyeres directs the blast to the center of the cupola so that it will not cut away the lining. In addition, this lining can be more easily repaired than the one shown in Fig. 1. The cupola will also hold nearly one-half more iron than Fig. 1, which makes it melt much faster. The bed should not be extended to a height of more than 18 inches above the tuyeres. The 200-pound charge of iron is too small for a 24-inch cupola and this should be increased to 300 pounds. In addition, all of your coke charges should be weighed. The correct charges should consist of 300 pounds of iron, one-half pig and one-half machinery scrap and 35 pounds of coke. If your charging door is at the proper height, you can charge 2,600

pounds of iron in a cupola this size before applying the blast. Your tuyere area is also insufficient. We are using a 21-inch cupola, which is equipped with six tuyeres, four inches in diameter through the shell, and four inches square at their inside ends. The area of the cross-section of a 21-inch cupola is 346 square inches, while that of a 24-inch cupola is 452 square inches and of a 28-inch cupola, 615 square inches. You will note that the 28-inch cupola has nearly twice the capacity of the 21-inch cupola and that the 24-inch cupola is nearly one-fourth larger. Your 24-inch cupola has a combined tuyere area of 28¼ square inches, whereas the 21-inch cupola, which we operate, has a tuyere area of 75 square inches. Your cupola should be provided with six tuyeres of a combined area of at least 100 square inches. This will enable you to reduce the blast pressure to about six or eight ounces. In cupola operation, volume of air and not a high blast pressure, is desired. It is doubtful if air will burn out the silicon, if it is applied at a high pressure in a small cupola and with a small tuyere area, as in your case. The only method by which hard iron can be obtained under ordinary conditions, is to have a low silicon content. To soften your iron, use a small amount of silicon iron in each charge. The cracking of the grate bars is due to unequal shrinkage. Gate them so that they will cool uniformly. On the other hand, grate bars should be made of very soft iron, instead of hard iron, and as the shrinkage of soft iron is less than that of hard iron, you will not be troubled with the cracking of the castings. An important point in melting is to light the fire two hours before the iron is desired. The height of the bed above the tuyeres must be fixed just before charging begins, which should be one hour before the iron is down, so that the charge is at the melting temperature when the blast is put on 15 minutes before the iron is tapped.

Transportation of Material in Foundries

By Oscar E. Perrigo.

WHILE it is true that in many of the recently erected foundries efforts have been made to systematize operations, nevertheless the transportation of materials in casting plants has not received the attention that has been devoted to this problem in machine shops and other industrial works. It is an easily demonstrated fact that in the routine of manufacturing operations the time required to handle the material in process of manufacture is frequently greater than the actual time consumed in the manufacturing operations. In a foundry the relative amount of raw material handled, particularly pig iron, coal, coke, etc., to which must be added the castings, is much greater than in a machine shop of proportionate size. Therefore, it can readily be appreciated that the relative importance of the subject of handling materials in the foundry is greater than in any other department of a manufacturing plant. Consequently the problem of eliminating labor waste in the foundry is of prime importance and the appliances and facilities for handling materials should receive careful consideration.

That this subject is of great importance is reflected by the constantly increasing types and designs of cranes, hoists, trolleys, etc., available for conveying materials in casting plants. These include traveling cranes, overhead trolleys and hoists, operated by hand, compressed air and electricity, shop and yard tracks and cars, hand or electrically-operated, stationary and traveling jib cranes, hand trucks and in addition to these are chain and belt conveyors for handling sand, castings, etc.

In Fig. 1 is shown the ground plan of a manufacturing plant, built 15 or 20 years ago, which is typical of the works erected at that time. The main buildings were constructed with high central bays adapted for the use of

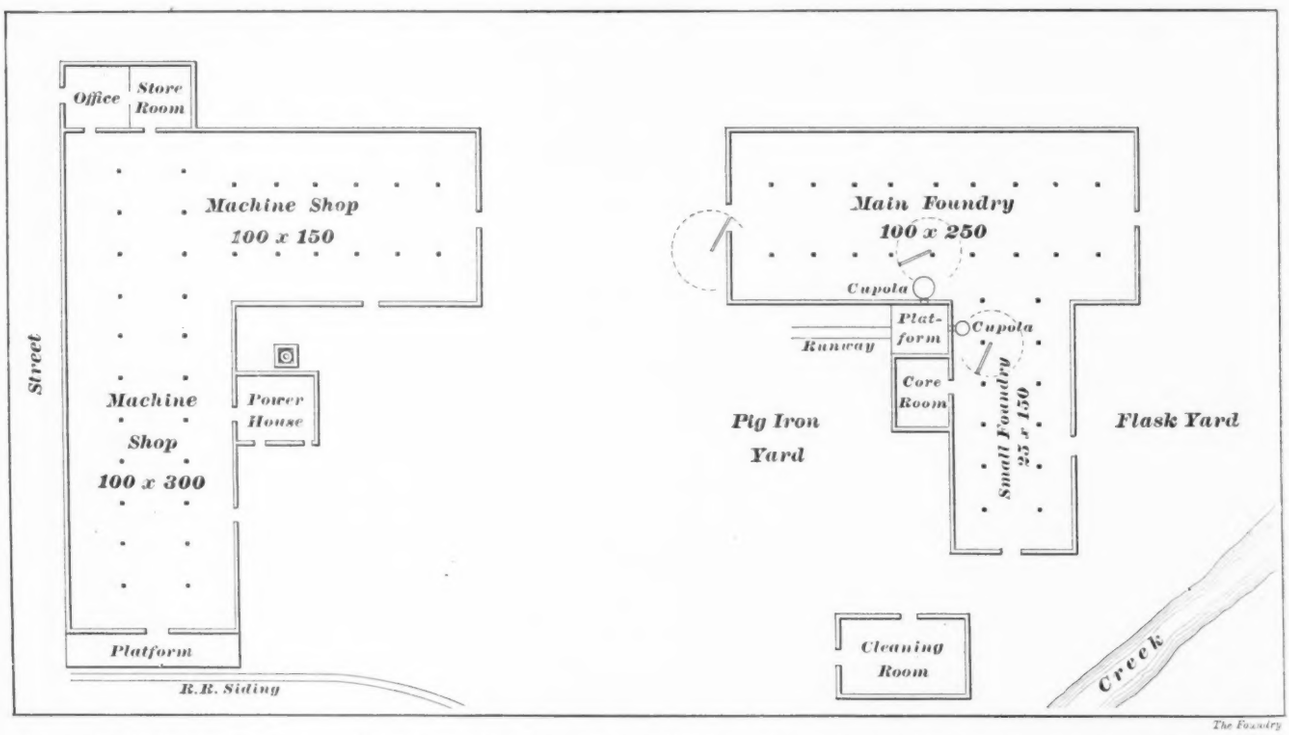


FIG. 1—PLAN VIEW OF PLANT AS ORIGINALLY ARRANGED WHICH CONTAINS PRACTICALLY NO INTER-DEPARTMENTAL TRANSPORTATION FACILITIES

traveling cranes and in some of the buildings the side bays were of sufficient height to permit of the installation of a balcony on which some departments of minor importance might have been located. The main foundry building of this plant is 100 x 250 feet and at right angles to this shop is a building, 75 x 150 feet, designed for small, light work. A cupola is provided for melting the iron for each department. The cupolas were so arranged that they could be charged from one charging platform. The core room adjoined the melting department and an ample storage yard for pig iron and fuel was located between the foundry and machine shop buildings, while on the opposite side of the small foundry was located the flask yard. The cleaning department was located in a small building near the light work foundry.

Main Foundry.

The main foundry was commanded by a traveling crane of good design and construction. The main machine shop building, however, was served by cranes of older design. For the purpose of handling the ladles at the cupolas, jib cranes were installed and these were also used for handling flasks and molds, which were too heavy to handle by hand. Another jib crane was located outside of the main foundry for the purpose of transferring large castings to the yard. No other transportation facilities were provided, other than wheelbarrows and a four-wheel truck drawn by a horse. Coke, pig iron, sand, etc., was transported from the yard to the foundry in wheelbarrows or by the four-wheel truck, and small and medium size castings were handled in a similar manner. As the distance between the foundry and machine shop was considerable, a large force of men was employed to transport the castings from the foundry to the finishing department.

Suggested Improvements.

After carefully examining the operating conditions of the plant, and particularly the facilities for handling materials in the foundry, the following suggestions were made for the installation of an effective transportation system:

First—Economical and rapid means of transporting flasks from the flask yard to any desired point in the foundry. Second—Effective and economical means of conveying the castings from the casting floor to the cleaning department. Third—The installation of a system for conveying the cleaned castings from the cleaning room to the machine shop. Fourth—A system for conveying the pig iron and fuel from the storage yard to the cupolas. Fifth—The installation of storage bins for raw material at a point in the yard convenient to the foundry and a railroad siding.

Experience in the machine shop proved conclusively that for conveying loads weighing up to 10 tons, cars pushed by hand operating on industrial tracks gave efficient service with suitable cranes or hoists for loading and unloading castings to and from the cars. It was, therefore, decided to make use of this means of transportation as far as possible. The traveling crane in the central bay of the foundry handled heavy loads economically in the central area which it commanded, but frequently several loads had to be handled simultaneously and the one crane proved insufficient. Therefore, it was believed that an industrial railway system would materially facilitate the handling of material in the middle bay of the foundry.

When planning the transportation system for the foundry, the industrial railway system was extended to the machine shop, as shown in Fig. 2, to facilitate the delivery of castings to that department. An industrial track was installed the entire length of the main foundry, encircling the entire storage yard and was extended to the small machine shop where it was connected by a turntable with another track which served this entire shop and extended to the store room at the opposite end.

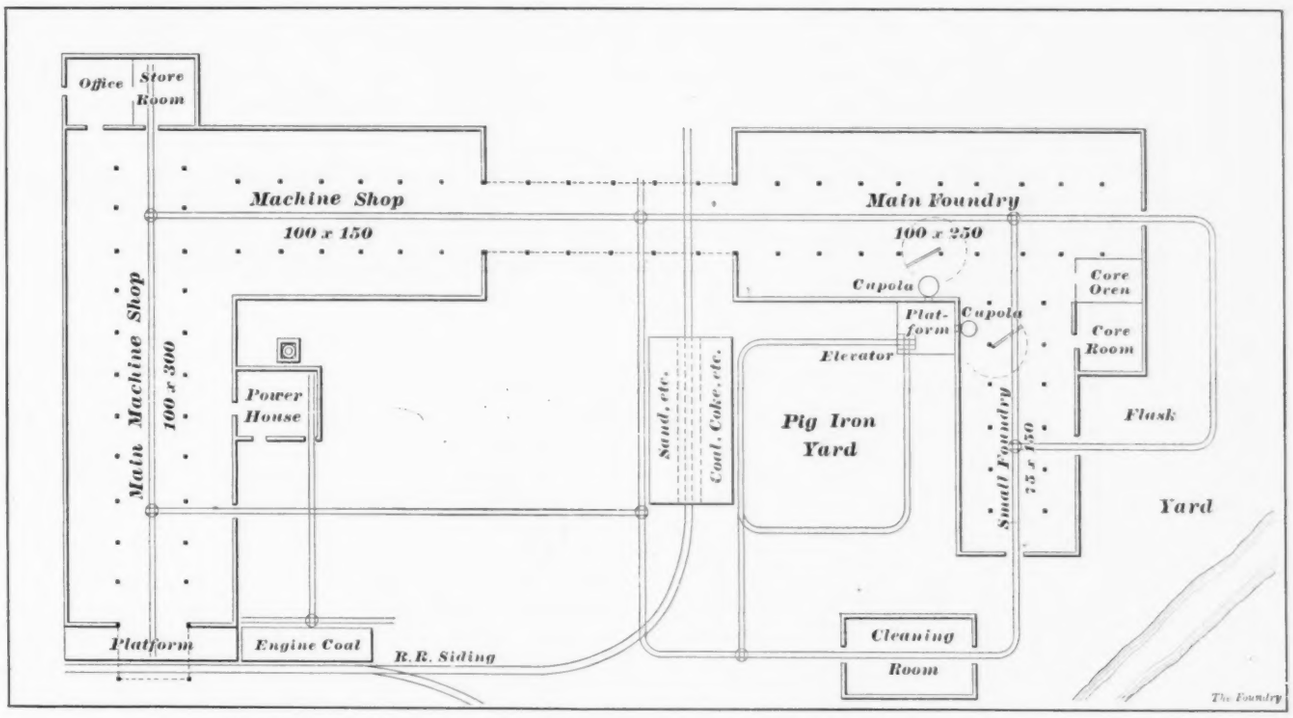


FIG. 2—PLAN VIEW OF PLANT, SHOWING THE TRANSPORTATION FACILITIES INSTALLED

Industrial Railway System.

The track in the main foundry extended through the rear door into the flask yard and connected with another track in the small foundry, which was also extended to the cleaning room, through which it passed and connected with a track in the main foundry. By this arrangement of tracks, flasks were conveniently carried back and forth

from the flask yard to any desired point in the foundry and castings could be easily transported from either foundry to the cleaning department. By either of two routes, cleaned castings could be carried to the machine shop. To handle large castings not usually delivered to the cleaning department, but which were pickeled, cleaned and washed in the yard, a crane runway was built which connected the main foundry with the machine shop. The doorways of these two buildings were extended in width to permit the passage of the crane in and out of these departments.

Shipping Facilities.

To facilitate the delivery of raw material the railroad siding was extended and passed underneath a crane runway, the jib crane outside of the main foundry having been removed. The doorway of the large machine shop leading to the shipping platform was enlarged and a crane runway was built over the standard gage track to facilitate the loading of large castings onto cars by the traveling crane. By continuing the track to the crane runway, facilities were also provided for shipping large castings direct from the foundry. Storage sheds were built over the standard gage track in the yard for sand, coke, coal, etc. For conveying coke, pig iron and scrap to the charging platform, a belt line track was laid to the elevator, which served the charging platform. The installation of compressed air equipment, including hoists, etc., also greatly reduced the cost of handling flasks, molds, castings, etc., in the foundry. The entire equipment paid a handsome dividend on the investment and the cost of maintainence was small. The problem of transporting materials in foundries offers a wide field for investigation and improvement by which great economies can be effected.

The Use of Silvery Iron

By W. J. Keep

Question.—We would like to have you advise us whether it is better to use pig iron containing the proper amount of silicon for our castings or to use irons low in silicon and to enrich them with silvery iron.

Answer.—Not many years ago, silvery iron was considered injurious in an iron mixture. In those days certain brands of iron were used by foundrymen for different classes of work, the brand being intended to produce the quality of casting required. The foundry foreman who could produce good castings with certain favorite brands was always insured a good salary. It was known that sulphur was very injurious, but it was believed that the only way to soften castings was to increase the percentage of No. 1 iron in the mixture, or by the addition of some particular brand. It was not until about 1885 that silicon was recognized as a softener.

If you can procure iron which contains the proper amount of silicon for your castings it is advisable, but you must have an analysis made of each car and the pigs from each car must be piled separately. You must also calculate a mixture which will produce a percentage of silicon satisfactory for your line of work. On the other hand, with one brand of iron in the yard containing from 5 to 6 per cent of silicon and the knowledge that high silicon makes soft castings, you can use this high silicon or silvery iron as most convenient. You can also use 50 per cent of machinery scrap for machinery castings without much reference to the percentage of silicon. If you know the percentage of silicon in the irons entering into your mixtures you can calculate the silicon in the entire mixture. If you believe the silicon of a machinery mixture should be 2.25 per cent, add sufficient of the 6 per cent silicon iron to obtain this percentage in the mixture, making the total 2.50 per cent silicon to allow for the loss in melting. If the castings are softer than necessary, the amount of scrap can be increased. The silicon will be found to be uniformly distributed and the grain of the castings will be close and in addition the iron will be as strong or stronger than that of a mixture not containing silvery iron. The use of silvery iron does not require great skill and the foundryman can be assured of good results from its intelligent use.

Casting Cannon Balls in the Eighteenth Century

By Joseph Horner

THE methods of molding and casting cannon balls in France in the eighteenth century, as depicted in a French encyclopedia, dated 1777, is shown in the accompanying illustrations. The permanent molds for cannon balls of various sizes are shown in Fig. 1. These molds are made of cast iron and the balls were, of course, chilled on their surface, as at that time the latter-day refinements of permanent mold practice had not yet been developed. It will be noted that the molds are doweled and the method of clamping the molds for casting is shown in the lower part of this illustration.

The method of making the cores for cannon balls cast in sand is shown in the upper half of Fig. 2. The process is similar to that of the cast iron pipe core shop practice of today. Straw rope was first wound around the arbor, as shown at *A*, in the lower half of Fig. 2. A coating of clay was then applied, which was struck off with a board, as shown in the upper half of Fig. 2. After drying this coat, another application of clay was made and this was subsequently dried before applying the finishing coat. The core, after the application of the first coat, is shown at *B*, and as finished is shown at *C*; *D* is a cross-section through the core. It will also be noted that the core for the opening in the cannon ball was turned onto the arbor with the large body core. In Fig. 3 are shown the flasks, and it will be noted that they reflect considerable ingenuity in their construction. The flasks were made in two parts and were fitted with three dowel pins as well as with guides on two sides, which are not unlike flasks in use in some of the small jobbing foundries in this country today. To reduce the amount of sand required for molding, the corners of the flasks were rounded. A copper pattern was used and to insure its central location in the flask, the bar, *C*, Fig. 3, was clamped over the flask, as shown at *A*, and at *B*, it will be noted, the drag half of the mold has been rammed with the pattern in position. This bar, as shown at *A*, Fig. 4, which was used for centrally locating the pattern, remained attached to the drag half of the mold and served as a support for the core arbor. The core arbor was also grooved to provide a vent for the escape of the gases from the core and the mold.

The drag pattern, as shown at *B*, Fig. 3, had four lugs that extended above the parting line, which were used for the purpose of centering the cope pattern. At *D*, Fig. 3, the cope pattern is shown in place with the sprue attached, and the entire copper pattern assembled is shown at *E*. To further support the core and to obtain the proper thickness of metal, two cores were inserted in the drag half of the

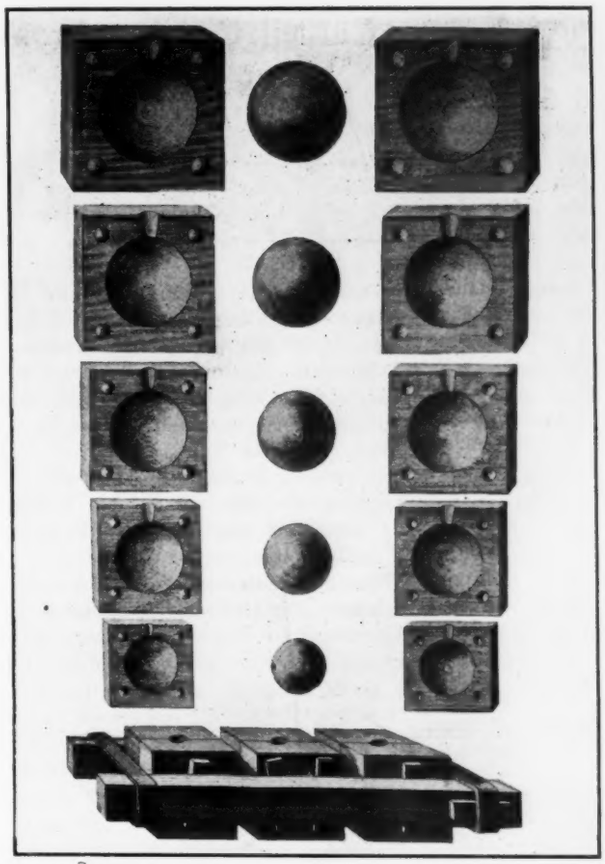


FIG. 1—CHILL MOLDS FOR MAKING CANNON BALLS

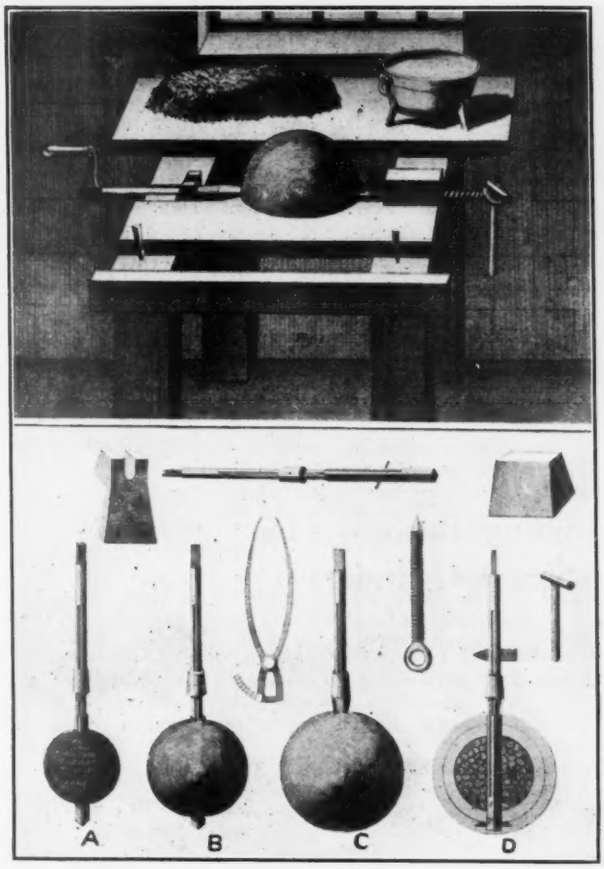


FIG. 2—METHOD OF MAKING CANNON BALL CORES

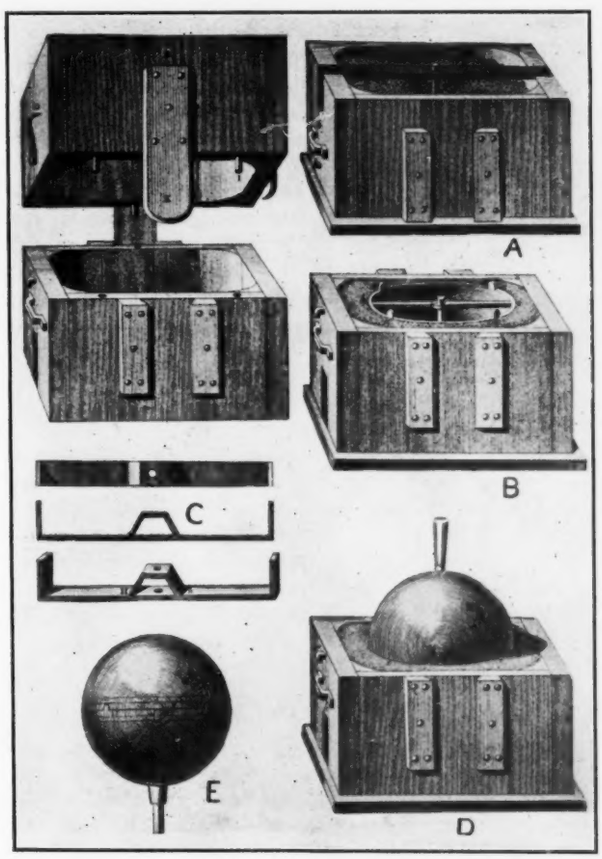


FIG. 3—FLASK AND METHOD OF MOLDING CANNON BALLS FOR CASTING IN SAND

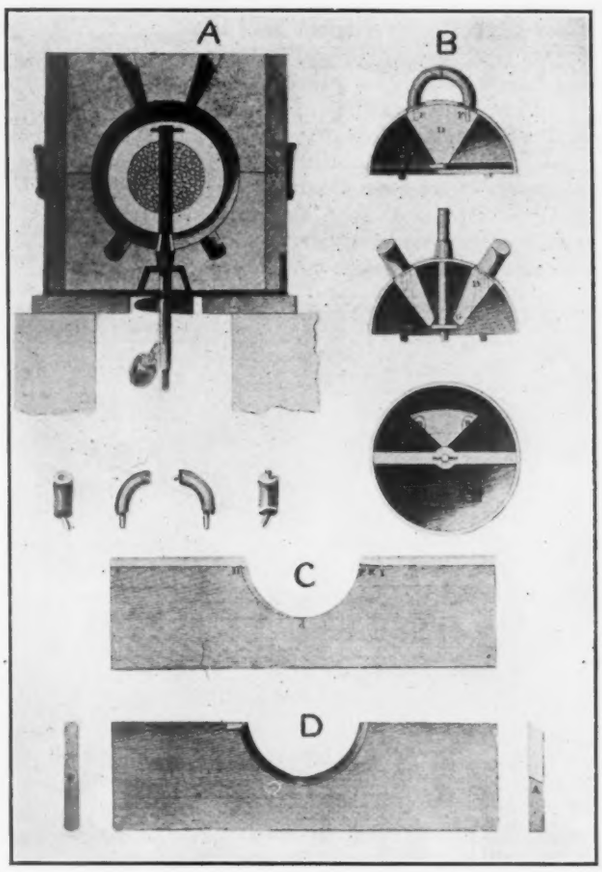


FIG. 4—SECTIONAL VIEW OF MOLD AND VARIOUS PARTS OF THE PATTERN

mold, the core prints being rammed when the drag was made. These two parts of the pattern are withdrawn from the mold through the drag pattern before withdrawing this pattern from the sand. The two gates are shown in position at *B*, Fig. 4, and are supported by a block of wood, held in position by a bar, while the cope is being rammed. When this bar was withdrawn, this block of wood was removed and this permitted drawing back the gate, which was made in two parts, into the pattern. The loam boards used for making the cores are shown at *C* and *D*, Fig. 4, respectively.

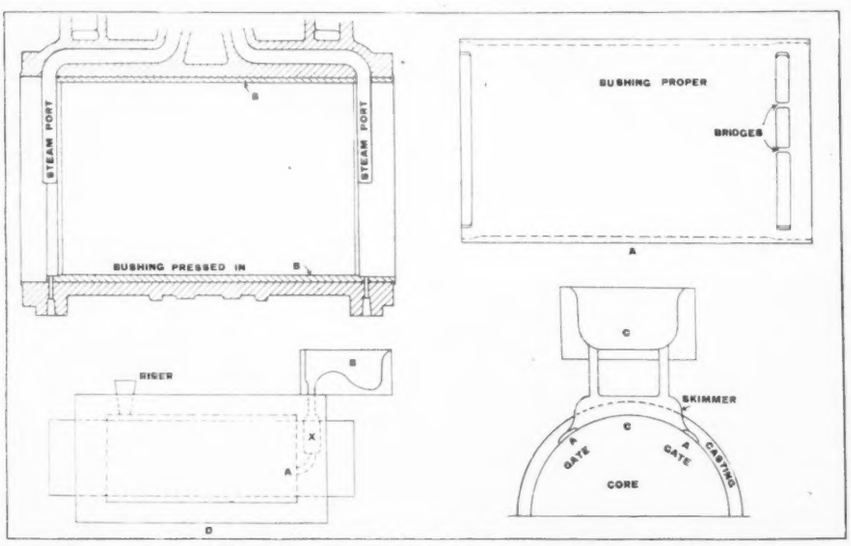
Molding Bushings for Steam Cylinders

By Louis Luhrsen

When the walls of a locomotive cylinder have been worn thin, a bushing is inserted in the cylinder, which is brought back to its original bore and, providing other parts of the cylinder are serviceable, this operation can be repeated several times. The iron in these bushings should be of good wearing quality, the strength being of minor consideration, as long as the casting is sufficiently strong to withstand the pressure required to force it into the cylinder. A suitable mixture for these bushings, that has given satisfaction, follows: Charcoal pig iron, 400 pounds; No. 1 coke pig iron, 300 pounds; machinery scrap, 800 pounds, and 1 pound of 80 per cent ferro-manganese added in the ladle. The analysis of this mixture is as follows: Silicon, 1.70 per cent; sulphur, 0.068 per cent; phosphorus, 0.61 per cent; manganese, 0.61 per cent; combined carbon, 0.70 per cent, and graphitic carbon, 2.25 per cent.

These bushings, shown in section in the accompanying illustration at *A*, and in position in the cylinder at *B*, were cast in dry sand in a vertical position. This practice has, however, been abandoned and they are now molded and cast horizontally in green sand, very clean and solid castings being obtained. The success of this method depends largely upon the system of gating, as it is necessary to provide basins sufficiently large, and of such a shape that they can be immediately flooded with metal in order to float off the impurities.

The iron should be hot, well stirred, carefully skimmed and the runner basin must be quickly filled when starting to pour, and afterward kept full until the mold is cast. The method of gating is clearly shown at *C* and *D*. In this illustration, *C* is a cross-section through the runner basin, and *D* is a longitudinal section of the mold and runner basin, while *X* is the skimming gate which straddles the core, the object of which is to entrap any dirt that may escape the basin. The position of the gate and riser and the shape of the runner basin are shown. While pouring, the riser end of the mold is elevated about 3 inches above the gate end, thus causing the iron to flow up-hill. The core is made on a barrel, covered on the outside with numerous projections to hold the sand. A regular core sand mixture is used which is swept on the barrel with a sweep guided by the turned ends of the barrel, which are ⅜ inch less in diameter than the core, thus providing space for the casting to contract and to permit of the easy removal of the barrel.



BUSHING FOR WORN-OUT LOCOMOTIVE CYLINDERS, SHOWING METHOD OF GATING TO INSURE CLEAN CASTINGS

Chilled Castings From Non-Chilling Iron

By W. J. Keep

Question.—We are frequently called upon to make chilled castings and we would like to know how they can be produced from a non-chilling mixture.

Answer.—The chief difference between a chilling and a non-chilling iron is in the percentage of silicon. With silicon below one per cent, the iron will produce a chill, but with silicon above two per cent it is not likely to chill. The addition of manganese will harden iron, but will not increase the chill. If sulphur is higher than 0.08 per cent it will impart a chilling tendency to the iron. As silicon must be high in a non-chilling mixture a variation of sulphur is the best way to impart a chill. To increase this element in the iron place a small piece of sulphur in the ladle, the iron being stirred to insure a good mixture. This iron is then poured into a mold containing an iron chill and if the chill is not sufficiently deep the sulphur can be easily increased. A handful of small steel clippings placed in the ladle onto which the fluid iron flows will frequently produce a chilling iron, but the steel in melting absorbs so much heat from the iron that the latter will be found to be too sluggish to run. If you have many of these castings to make it will be advisable to make a hard iron charge in the cupola. The first charge should contain the hard mixture. The cheapest chilling mixture can be made from scrap car wheels or plow points, the depth of chill being governed by the amount of soft gray iron added to the mixture.

A Japanese Pipe Foundry

The pipe casting department of the Kamaishi Steel Works, Japan, was erected in 1903 and has a daily capacity of 50 tons. Small pipes are cast vertically in circular casting pits equipped with jib cranes. Pipes of medium and large size, up to 36 inches, are cast in square pits. The molds are dried by producer gas and the cores are baked in ovens heated by wood and coke. A typical analysis of the better grade of coke pig iron made by the blast furnaces at these works, follows: Graphitic carbon, 2.85 per cent; combined carbon, 0.62 per cent; silicon, 2.82 per cent; phosphorus, 0.13 per cent; sulphur, 0.03 per cent; copper, 0.25 per cent, and manganese, 0.40 per cent.

USES OF ELECTRICITY IN FOUNDRIES*

A discussion of the advantages of electric motor drive for machinery used in casting plants

By Brent Wiley

WITH the advent of the electrical overhead traveling crane about 18 years ago, electricity became a governing factor in perfecting foundry methods, and today the general and most important advantages offered by electric drive for practically the entire machine equipment are well established. However, there are many features of electrical engineering as applied to the foundry which are the objects of continued attention and study on the part of the foundrymen and all others interested in foundry engineering, including the electric manufacturing companies, and it is the object of this paper to review the most important subjects, including the advantages of the system and apparatus best adapted for the various applications and point out to what extent the question of economies can be effected by the present day developments of the art of electric drive and general applications of electricity.

The advantages of electric motor drive for machinery used in the foundry may be summed up as follows:

(1) Adaptability of motors to all classes of service by reason of compact construction, substantial characteristics and flexibility of mechanical and electrical design.

(2) Wide speed range, ease and certainty of control; automatic devices insure the safety of the motor and the driven machine.

(3) Easy and inexpensive distribution of power by electric conductors and the saving of power by direct connection of motor to machine, eliminating line shaft and belting.

(4) Advantages of centralized power.

It is quite logical to state that these advantages are well established in the minds of foundrymen since electric drive has been adopted so universally. It would be well, however, to review these applications in order to recall to mind the exact conditions of operation, and consequent requirements of motor characteristics of power supply system, best suited from a general engineering standpoint.

Iron Foundry.

In the iron foundry the applications of motor drive may be summed up as follows:

Stock Yard. — Overhead traveling crane; magnet for handling pig iron and scrap; skull cracker for breaking scrap.

Cupola.—Positive blower or fan type and elevator.

Molding Floor.—Cranes, overhead, traveling or jib, molding machines, core machines, sand cutter or mixer and sand sifter, traveling tables, sand elevators and sand conveyors for special foundries.

Pouring Floor. — Cranes—overhead, traveling or jib.

Cleaning and Finishing Department.—Crane, tumblers, grinders, lathes, shapers, drill press, planer, etc.

The applications of electric drive in the steel foundry, follow:

Stock Yard. — Overhead traveling crane, magnet for handling pig iron and scrap and skull cracker hoist.

Furnace Department.—Charging machine.

Molding Floor.—Crane, overhead, traveling or jib; sand mill and molding machines.

Pouring Floor. — Crane, overhead, traveling or jib.

Cleaning and Finishing Department.—Crane, cold saw, grinder, lathe, planer, shaper and drill press.

Application Common to All Foundries.—Air compressor, fans for ventilating and heating, pumps, coal and ash handling machinery and pattern and machine shop machinery.

It is not the intention to give engineering details such as number and capacity of cranes and capacity of motors for the various applications of the foundry, but to analyze the general conditions and give data that will assist in arriving at proper power house equipment and systems of power best adapted to the conditions.

A thorough analysis of several large steel and iron foundries was made with particular reference to electrical installations, operating conditions and

*Presented at the Pittsburg convention of the American Foundrymen's Association.

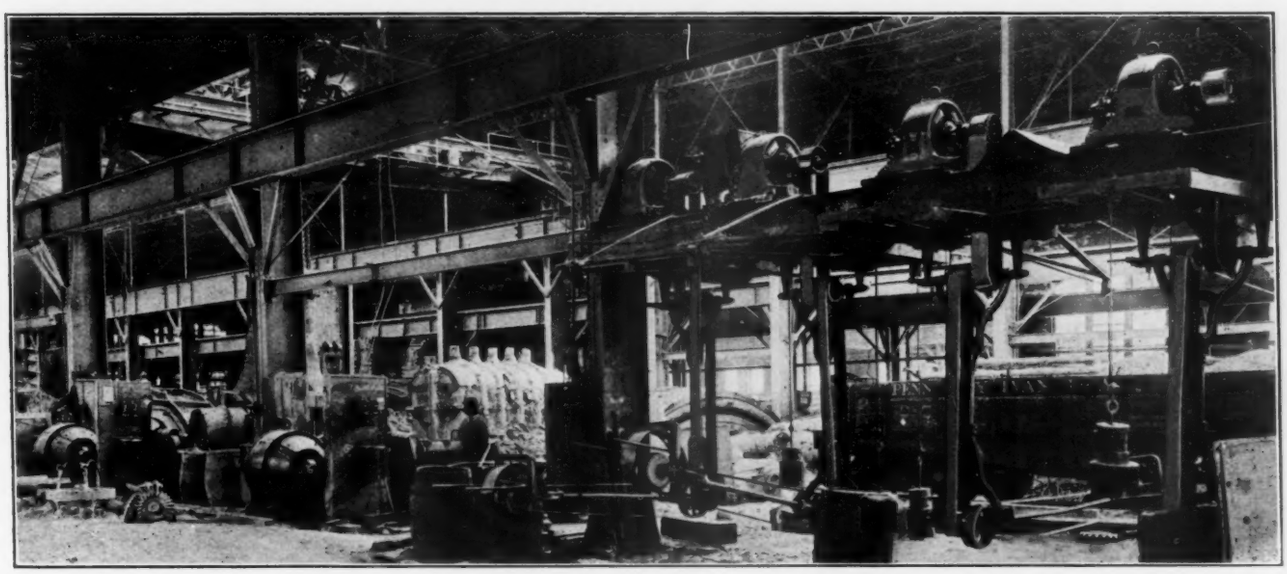


FIG. 1—MOTOR-DRIVEN MACHINERY IN THE CLEANING DEPARTMENT OF THE VANDERGRIFT, PA., FOUNDRY OF THE UNITED ENGINEERING & FOUNDRY CO., PITTSBURG

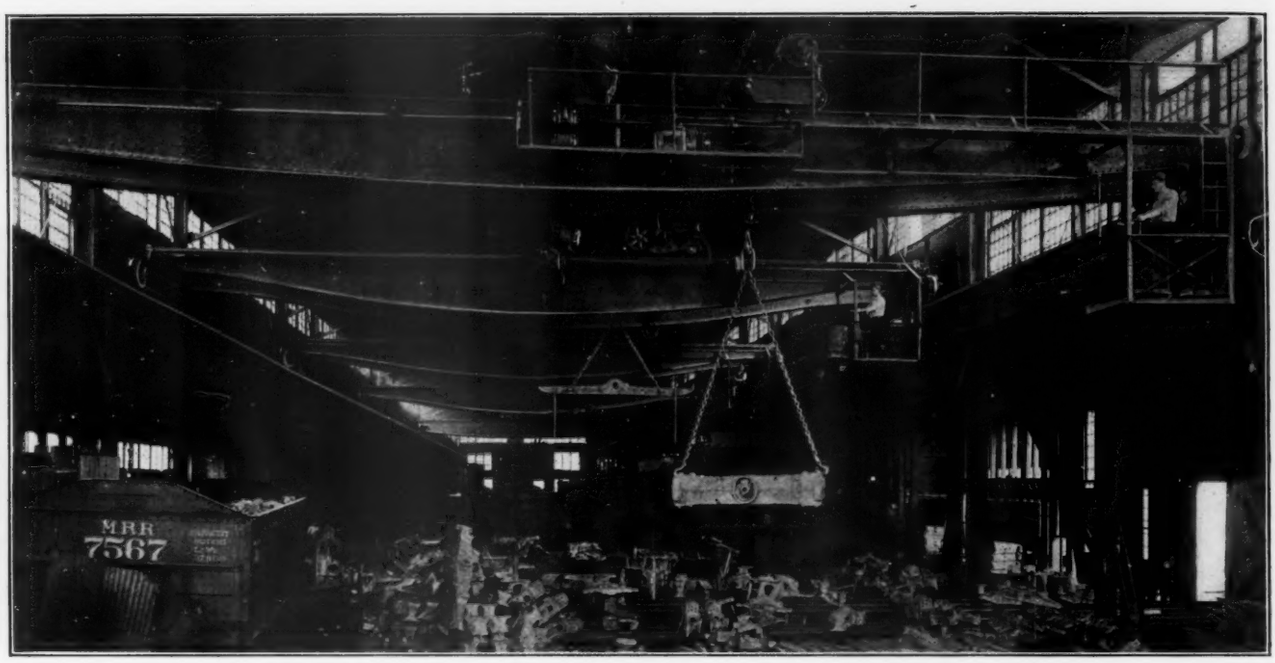


FIG. 2—MAIN FLOOR OF THE PITTSBURG STEEL FOUNDRY CO.'S PLANT, SHOWING THE AMPLE ELECTRIC CRANE FACILITIES FOR HANDLING LARGE CASTINGS

power requirements. These foundries were of the modern type with electrical drive throughout and were equipped with overhead traveling cranes in each department. The capacities ranged from 1,500 to 2,000 tons per month and the weight of the castings varied from 100 to 100,000 pounds with an average of 250 pounds. The electrical equipment was 220-volt, direct current, with one exception, which included 400-volt, 3-phase, alternating-current machines. The average conditions for these foundries are shown in the accompanying table.

A general rule for power house capacities is that the average load will be approximately one-third the total capacities of floor motors and crane hoist motors. In figuring the crane load on the power station, it is to be noted that as the hoisting motion of the crane gives the heaviest load and as it is seldom that more than one motion is used at a time, it is sufficient to consider the load on this motor only. As the crane work is very intermittent, the load is very fluctuating and the total capacity of power generators should not be less than twice the average load. As a general rule, a spare generating unit will prove a paying investment to insure ample power at all times.

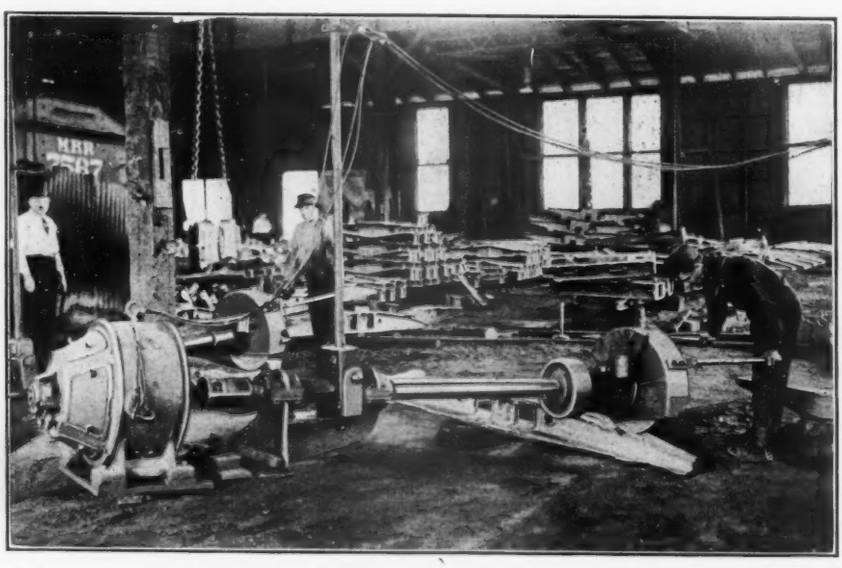


FIG. 3—A MOTOR-DRIVEN, DIRECT-CONNECTED GRINDER USED FOR GRINDING STEEL CASTINGS

For the above conditions the average power house load $= \frac{329 \text{ plus } 400}{3}$ = 243 horsepower = 181 kilowatts, and two 175-kilowatt generators would be sufficient.

Electrical Equipment in Foundries.

FLOOR MOTORS.

	Number	Size, horsepower.	Total horsepower
Air compressor	1	75	75
Cold saws	2	20	40
Sand mills	2	30	60
Grinders	8	5	40
Machine shop	6	..	50
Repair shop	1	25	25
Miscellaneous	5	..	39
Total	25	..	329

CRANES.

	Number.	Capacity tons.	Total horsepower.
Air compressor	2	50	280
Cold saws	3	25	250
Grinders	4	10	180
Machine shop	2	5	90
Total	11	..	800

TOTALS.

	Horsepower.
Floor motors	329
Crane motors	800
Crane hoist motors	400

Or figured on another basis, it requires approximately 35 kilowatt hours per ton of steel castings and approximately 45 kilowatt hours per ton of iron castings, for foundries with electrical equipment and capacity as given above. The blast for the cupola of the iron foundry and the greater amount of small work, increases the electric power per ton output.

The values given for power house capacities include power for lights

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication.

FORMULAS FOR FINDING THE WEIGHTS OF IRON CASTINGS.

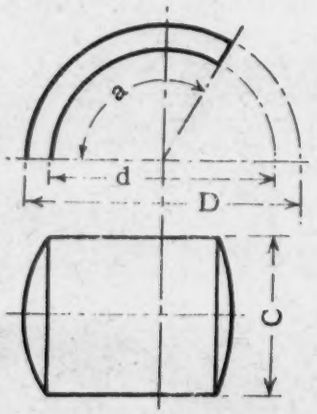
By W. L. Tryon

To find the weight of a sector of a ring made by cutting a cylindrical hole through the center of a sphere, multiply the chord cubed by the number of degrees in the angle by 0.000379.

$$W = C^3a \times 0.000379.$$

The chord is equal to the square root of the result obtained by subtracting the square of the diameter of the hole from the square of the diameter of the sphere.

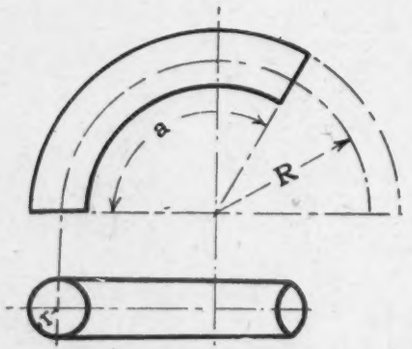
$$C = \sqrt{D^2 - d^2}.$$



W = Weight of casting in pounds.
D = Diameter of sphere in inches.
d = Diameter of hole in inches.
C = Chord in inches.
a = Number of degrees in the angle.

To find the weight of a sector of a ring of circular cross-section, multiply the radius of the cross-section squared by the radius of the circle passing through the center of the cross-section by the number of degrees in the angle by 0.01428.

$$W = r^2Ra \times 0.01428.$$



W = Weight of casting in pounds.
r = Radius of cross-section in inches.
R = Radius of circle passing through center of cross-section in inches.
a = Number of degrees in the angle.

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FORMULAS FOR FINDING THE WEIGHTS OF IRON CASTINGS.

By W. L. Tryon

To find the weight of a sector of an inside circular fillet, multiply the difference between the diameter of the cylinder made by the side of the fillet and the product of the radius and 0.446 by the radius squared by the number of degrees in the angle by 0.000488, or

From the diameter of the cylinder made by the side of the fillet multiplied by the radius squared by the number of degrees in the angle by 0.000488, subtract the radius cubed multiplied by the number of degrees in the angle by 0.000218.

$$W = (D - 0.446R)\ R^2a \times 0.000488,$$

or

$$W = DR^2a \times 0.000488 - R^3a \times 0.000218.$$

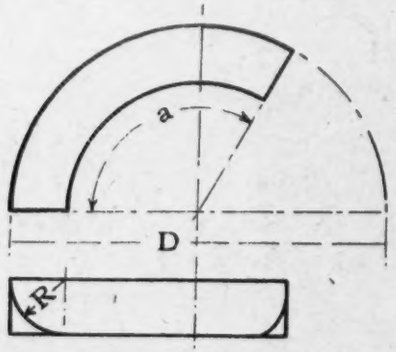
To find the weight of a sector of an outside circular fillet, multiply the sum of the diameter of the cylinder made by the side of the fillet and the product of the radius and 0.446, by the radius squared by the number of degrees in the angle by 0.000488, or

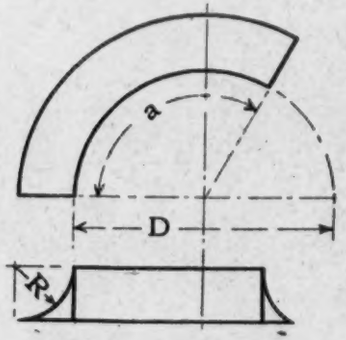
To the diameter of the cylinder made by the side of the fillet multiplied by the radius squared by the number of degrees in the angle by 0.000488, add the radius cubed multiplied by the number of degrees in the angle by 0.000218.

$$W = (D + 0.446R)\ R^2a \times 0.000488,$$

or

$$W = DR^2a \times 0.000488 + R^3a \times 0.000218.$$





W = Weight of casting in pounds.
R = Radius of fillet in inches.
D = Diameter of cylinder made or generated by the side of fillet in inches.
a = Number of degrees in the angle.

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Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form.

FIG. 4—MOTOR-DRIVEN, CONTINUOUS MOLDING TABLE, SAND ELEVATOR AND SAND CONVEYOR IN THE WESTINGHOUSE AIR BRAKE CO.'S FOUNDRY

and other auxiliaries, such as electric welding for steel foundries and machinery for repair shop and pattern shop.

The following general conditions for foundries, as previously mentioned, have been established. The capacity of the floor or constant speed motors is approximately equal to the capacity of the crane hoist motors:

(1) The average station load equals one-third the total capacity of floor motors and crane hoist motors.
(2) The maximum station load equals approximately twice the average load.
(3) The average distance for distribution of power is 600 feet or less.
(4) The applications of adjustable speed motors are few except where considerable machine work is done, in which case, the power will seldom be over 15 per cent of the total station capacity.
(5) The lighting load will average from 10 to 12 per cent of the total load.

The majority of the motor-driven foundry apparatus is located in the main working rooms and is, therefore, subject to a very dusty and gritty atmosphere and this is particularly so in the cleaning and grinding departments. While in the past, it has been almost a universal practice to connect the motors to the driven machines by means of belting, there is a decided tendency at this period to connect the motor in a more direct manner, either by gearing or direct drive. This applies particularly to grinders, machine tools, air compressors, fans and blowers. There is excessive wear of the belt on account of the grit and dust in the air and on account of slippage due to overloads, and in some cases, such as grinders, considerable power is saved by a more direct connection of the motor.

Direct Drive.

The present designs of motors have been developed to meet these improved methods of drive. The frames, and especially the shaft and bearings are made stronger, and arrangements are provided to dust-proof the bearings. The windings are of a more substantial form and are well-braced, and from an electrical standpoint, improved characteristics are provided such as high starting torques, excessive overload capacities and greater range of speeds. In general, a decided improvement has been made in the all-over efficiencies and reliability of motors for this class of service.

The most common electrical questions are, "Which is the better system to adopt, alternating current or direct current?" and "Why and what should be the characteristics of the system adopted?"

For the average foundry as previously described, in which crane service is the most important feature,

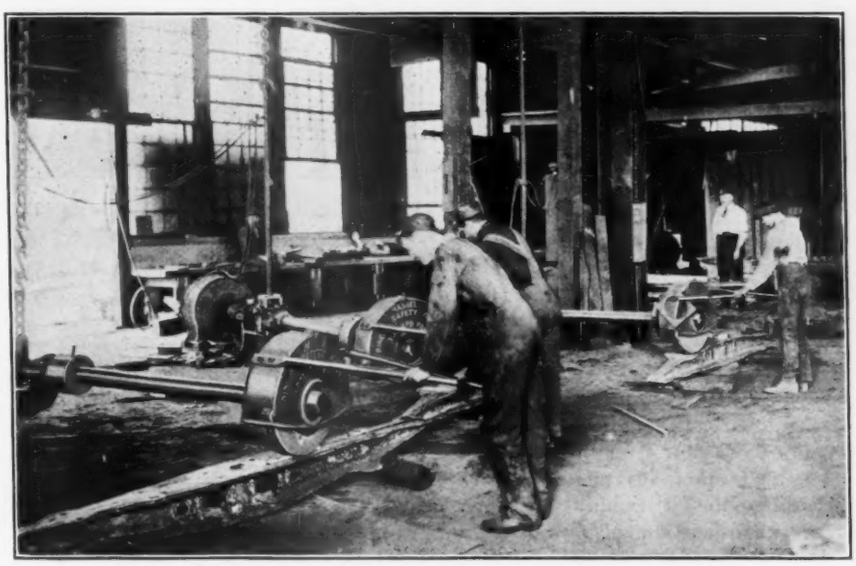

FIG. 5—ANOTHER VIEW IN THE PITTSBURG STEEL FOUNDRY CO.'S PLANT, SHOWING MOTOR-OPERATED, DIRECT-CONNECTED GRINDERS, AND THE EASE WITH WHICH THEY CAN BE HANDLED IS APPARENT

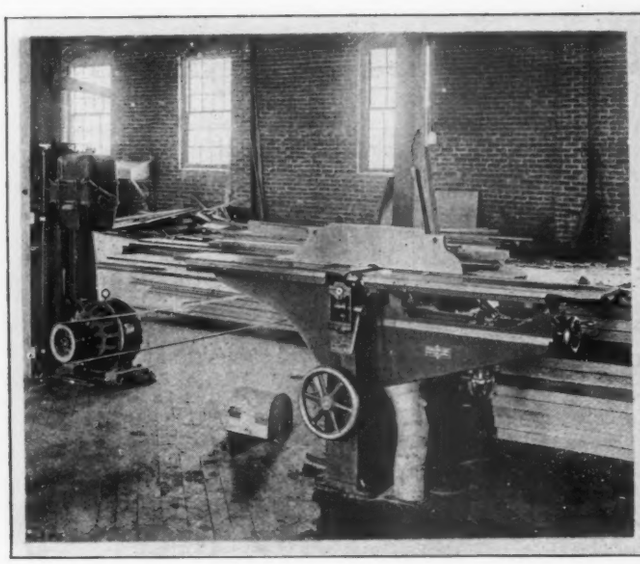

FIG. 6—A MOTOR-DRIVEN PLANER IN THE PATTERN SHOP

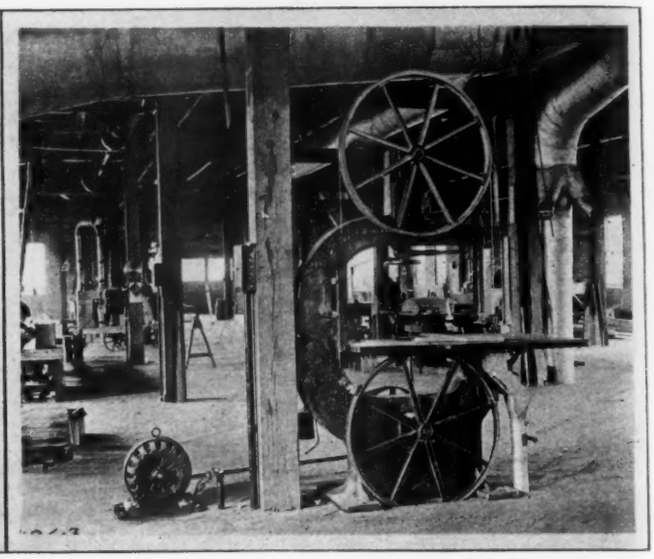

FIG. 7—MOTOR-DRIVEN, PATTERN SHOP BAND SAW

and the power station capacity ranges from 300 to 500 kilowatts with the average distributing distance approximately 600 feet, the 250-volt, direct current system offers many advantages. Direct current motors can be used for all the applications and as no converting apparatus or exciters are necessary, the power station equipment is simplified.

Direct current series motors have a speed torque curve, especially suitable for crane work as the speed varies with the load. The motor gives rapid acceleration, due to large starting torques obtainable and it will stand excessive overloads. Direct current, adjustable speed motors are especially suitable for machines such as the lathe and drill press, which may require a speed range of two to one, or even more, and also for cupola blowers where speed change is desirable.

As the distance of distribution of power is short, 250 volts is sufficient to permit a low line loss with a reasonable cost for copper.

Alternating Current Advantages.

In the case of foundries producing small castings, the overhead traveling crane is seldom used and the floor machinery constitutes the principal motor applications. The alternating current system offers many advantages for this class of foundry, namely, simplified and more durable construction of motor, better lighting system and other advantages.

At this point it would be well to discuss the question of power proposition as offered by the large central station companies. It will be noted that the foundry power load is very fluctuating, giving approximately a 50 per cent load on the station. This means exceedingly low steam economy, especially with reciprocating engines. The foundry station is comparatively small and is in operation 24 hours a day. Therefore, it should contain a spare unit for emergencies.

Central Station Power.

All of these factors tend towards a high cost of power. The central station being of large capacity does not feel the direct effects of the load fluctuations, for the peaks of the various loads tends to overlap in such

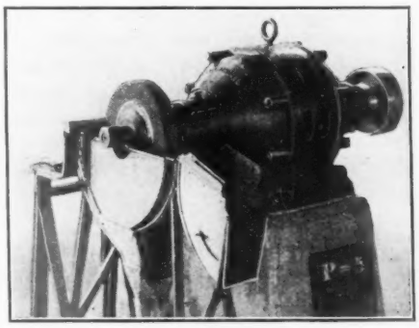

FIG. 8—MOTOR DESIGNED FOR THE DIRECT MOUNTING OF GRINDING WHEELS ON EACH END OF THE SHAFT

a manner that a more uniform load condition exists. The load being practically continuous, improves this load factor. Thus, to the small plant, especially, the central station companies can often offer good inducements to purchase power.

Lighting is the principal load of the central station and the system most generally adopted is alternating current, 3-phase, 60-cycle. The power is either generated at a high voltage or is stepped up to a high voltage by means of transformers for economy of transmission. The alternating current system thus offers a decided advantage over the direct current system, when the question of transmission is much of a factor.

In the case of an existing plant having direct current motors installed, a rotary converter could be used to convert the power to direct current of suitable voltage. If the proposition relates to a new plant, then a more economical plan will be to use alternating current motors, although in a majority of the cases, it will be necessary to reduce the voltage. Usually the transmission voltage will be over 1,000 volts and transformers should be used to give 240 volts for distribution within the foundry. Considerable discussion has taken place between the electrical engineers of the iron and steel industry during the last two years regarding the most suitable voltage for inner works distribution and from a safety standpoint, it has been decided that 240 volts for 220-volt alternating current motors and 250 volts for 230-volt direct-current motors should be used and these voltages are becoming standard for this class of industry.

Standard Voltages.

The alternating current, squirrel cage, wound motor offers several advantages over the direct current motor for the floor machines, with the exception of the applications requiring adjustable speed, such as machine tools and for these applications it would be best to install a small motor generator set to give direct current. The advantages are as follows: Simple construction of windings and es-

pecially the rotating element with the attendant advantages of absence of commutator and wearing parts, such as brushes; ability to stand excessive overloads. These several advantages mean less up-keep cost and in a general way, more reliability.

While it is true that the characteristics of the direct current series motor is more suitable than the alternating current motor for crane service, very satisfactory results are given by the latter and in the case of a foundry purchasing power from a certain station, where it would be necessary to install converting apparatus, to obtain direct current, the increased cost of installation and loss of efficiency will hardly warrant installing a mixed system.

Some of the principal reasons for purchasing energy from the central station are as follows:

Investment for power apparatus limited to motors and wiring. In new installations, the cost is usually less than for mechanical systems of power distribution.

No investment required for land, or floor or space for power equipment.

No investment for power plant and repair parts.

The money saved by the lack of power house may be invested in the business where it will return its share of profit.

The production and marketing of the power is a sole reason for the existence of the central station, consequently every effort is made by the management to improve the service in every possible detail; power is absolutely reliable.

There is no possible chance for complete shut-down due to an accident to any machine. The reliability of supply is in no respect dependent on one man's watchfulness; seldom is a skilled workman required in the factory to care for the power equipment.

No high pressure boilers and no opportunity for explosion.

No delays, due to insufficient power.

Cost of overtime work per machine no more than for the regular operation.

The power cost is directly proportional to the factory output, since the power consumed is proportional to the work done.

No increase in power plant equipment required for factory extensions; the central station takes care of all increases in the demand for power.

Electric power may be tried for a more or less extended period, and proven satisfactory, without making expensive changes in the equipment, before extending it throughout the factory.

Owing to the larger size and to the use of voltage regulating the devices, central stations provide a steady voltage without undesirable fluctuations.

Referring again to the subject of power supply, the coal consumption (using good grade of coal) is 10 to 12 pounds per kilowatt hour for the average condition of load, varying from 30 to 125 per cent and averaging 50 per cent. This means that the efficiency is about 25 per cent less than a uniform load, ranging from three-fourths to full load. For these conditions, especially the auxiliary pole, direct current generator offers several advantages—the commutating conditions are greatly improved and the practical overload capacities are increased.

While it is possible to obtain a load which will be uniform within 5 or 10 per cent by means of a storage battery, it is questionable whether it offers a paying advantage for the average conditions. However, in the case of one plant inspected, the crane capacity is exceptionally high, including 20 cranes of 358 tons total and the total of floor motors is 600 horsepower.

In the case of plant enlargement, it would be well to consider the low pressure turbine using the exhaust steam from the existing engines. By this means, at least 75 per cent additional power can be obtained without an additional coal consumption.

It is very doubtful if the average steam plant of the foundry, under the most favorable conditions, regarding price of fuel, etc., can produce the power for less than 2 cents per kilowatt hour and for the majority of the plants, the cost will be even higher. Only a few of the plants are equipped with instruments for measuring the total power and for a new plant especially, it is recommended that integrating meters be installed and an accurate record of power conditions be kept. It is not sufficient to base an estimate for a particular plant on the records of a few days, but rather on the average of several months. Other data relating to power costs should be recorded and a definite cost established. Until this is done, the question of power economies cannot be analyzed with any degree of accuracy and the advantages of the various suggestions which are sure to be considered from time to time, established.

One of the most important applications of electricity in the foundry is that of lighting. The natural conditions of dust and dirt as well as steam in the air, the crowded condition of the floor and the preponderance of dark surfaces, present difficulties, which make satisfactory lighting for the foundry a very much involved question. The light must be well distributed and of good intensity, and necessarily penetrating. These requirements must be met to insure the efficiency and accuracy of the work of molding especially, and as a precaution against accident in the general work of the foundry, particularly on the pouring floor.

System in Annealing Malleable*

By W. P. Putnam

THESE investigations were undertaken to emphasize the importance of improved methods in the manufacture of malleable castings, and to call attention to some of the sources of error so frequently found when the annealing process is conducted according to individual judgment, instead of by scientific methods. There is no branch of the foundry business that requires closer supervision than the process of annealing malleable castings; there is no department of a malleable works where greater skill is required, nor where greater economies can be effected, and yet, it is safe to say, that there are few foundries that recognize the importance of equipping their annealing ovens with appliances that would insure uniformity of results.

To call attention to the variations in the quality of castings that can be produced during the annealing process, a number of test bars were made and sent to various malleable foundries to be annealed in accordance with their usual practice. The bars were all made of the same metal, and to obtain castings free from shrinkage in the center, the ends were made large. In all the bars broken, but little draw was found. The analysis of the iron that was used for the bars is as follows:

	Per cent.
Silicon	0.74
Sulphur	0.041
Phosphorus	0.148
Manganese	0.24
Combined carbon	2.70

The chemical and physical properties of the annealed bars are shown in the accompanying table.

It will be noted that in each case where the bars were subjected to a long period of annealing or higher temperatures than necessary, the carbon was nearly all removed. Either practice is wasteful and will produce poor malleable iron. The annealing

*Presented before the Detroit Foundrymen's Association.

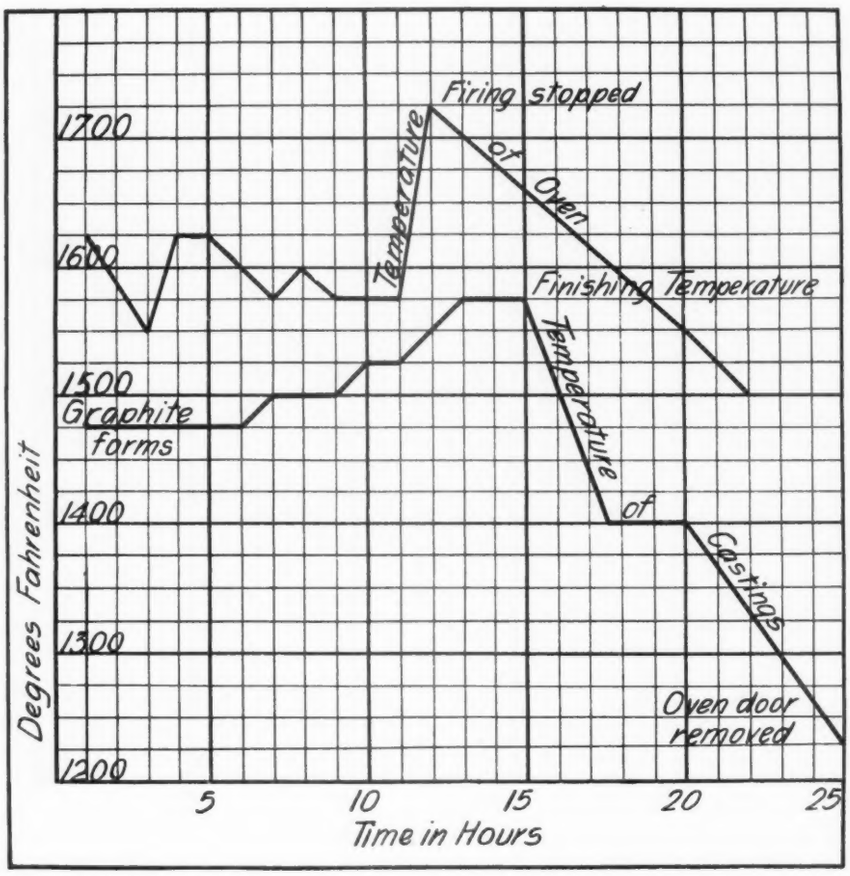

FIG. 1—CURVE OF A TYPICAL ANNEALING CYCLE, SHOWING THE TEMPERATURE OF THE OVEN AND CASTINGS INSIDE OF THE POTS. TO HEAT THE CASTINGS TO 1,475 DEGREES REQUIRED 38 HOURS; TO HEAT THE OVEN TO 1,625 DEGREES REQUIRED 29 HOURS

there is no further rise in the temperature of the metal until all the carbon has been changed into the graphitic form. As soon as this change has occurred, the temperature will rise in accordance with the temperature of the oven. It has been found that to heat the castings much above the proper annealing temperature for a long period is not only unnecessary, but a waste of fuel and produces poor castings. After the carbon has all been changed the oven need not be fired for more than six hours. When the metal has gradually cooled to 1,200 degrees Fahr., the cooling can be hastened as rapidly as desired without injuring the quality of the castings.

Some of the reasons why hard and brittle castings are occasionally found may be summed up as follows:

(1) Under-annealing, which may be caused by too low a temperature or by holding the castings at the proper temperature for too long a period. (2) Too rapid cooling of the castings after being annealed. (3) Heating annealed castings above the critical temperature to straighten, without subsequent annealing.

That there is need of the systematic handling of the annealing process, is clearly evident from the results given in the accompanying table. The variations shown are typical of castings in general.

Chemical and Physical Properties of Annealed Bars.

Test bar No.	Total carbon, per cent.	Graphitic carbon, per cent.	Combined carbon, per cent.	Elastic limit, pounds square inch.	Tensile strength, pounds square inch.	Elongation per cent in 2 inches.	Reduction in area, per cent.	Kind of packing.	Time of anneal. total hours.	Annealing temperature. degrees Fahr.
1	1.49	1.49	trace	29,823	40,996	8.59	12.13	slag	112	1450
2	1.94	1.94	trace	34,134	44,034	10.15	13.87	mill scale	114	1700
3	1.47	1.47	trace	29,276	39,638	8.59	17.63	mill scale	101	1620
4	0.86	0.77	0.09	31,428	48,489	8.59	19.18	not given		
5	1.74	1.74	trace	30,960	45,760	8.59	14.88	not given		
6	1.71	1.71	trace	28,326	40,408	8.59	15.00	none	72	1650
7	1.32	1.78	0.14	32,224	49,107	8.59	13.23	not given		
8	0.80	0.80	trace	33,333	47,336	7.60	17.27	slag	208	1629
9	1.58	1.58	trace	30,333	39,862	7.03	10.51	mill scale	163	not given
10	0.40	0.40	trace	41,792	50,849	7.45	20.92	mill scale	96	2200
11	1.32	1.32	trace	35,042	45,213	7.80	12.56	slag	144	1700

process should be conducted to produce definite results. Metal intended for parts to be machined should be treated differently in the annealing process than metal that is not machined. To find the correct annealing temperatures the critical and proper annealing temperatures were ascertained on a number of hard iron specimens ranging from 2.35 per cent to 3 per cent total carbon. These temperatures were diagrammatically shown in the chart, Fig. 2, and are accurate within 10 degrees Fahr. Fig. 1 shows the curve of a typical annealing cycle in an oven containing 14 tons of castings. The carbon in this lot of iron was 2.65 per cent. After the metal reaches the annealing temperature

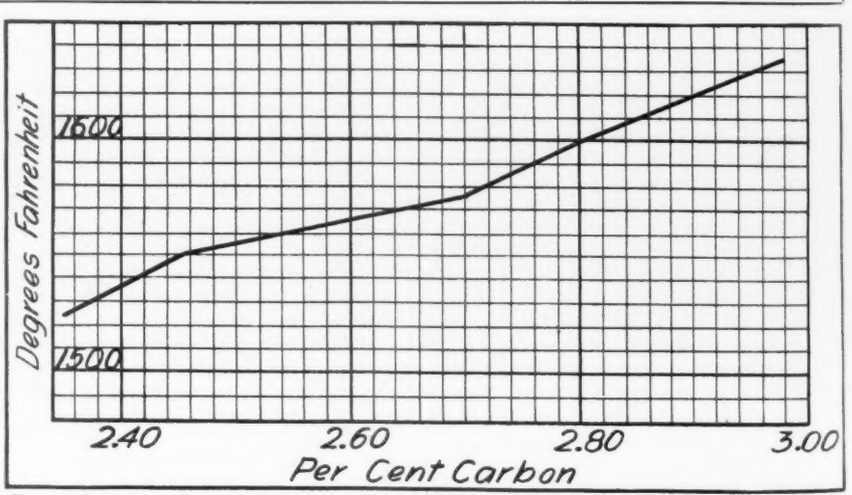

FIG. 2—PROPER FINISHING TEMPERATURE FOR WHITE IRON IN RELATION TO CARBON CONTENTS

AN OIL-FIRED STEEL CONVERTER

New type of converter in which the iron is melted and converted into steel by hot blast

A NEW type of oil-fired converter in which the iron is melted for conversion into steel and in which hot blast is employed for blowing the steel has been in successful use at the plant of the Darlington Forge Co., Darlington, Eng., for more than 12 months. This converter apparently affords a solution of the problem of the economical production of a limited output of small steel castings. In ordinary converter processes, in addition to the expense of the vessel and equipment, a cupola and its appurtenances is also a necessary feature. This expenditure is avoided when the charge is melted and converted in the same vessel. From the steel producer's point of view, the most important feature of the oil-fired converter is the fact that owing to the use of liquid fuel, no impurities are introduced into the metal during the process of manufacture. Other considerations are the elimination of the cupola and its accessories, the possibility of using pig iron low in silicon, and the use of a higher percentage of scrap, which is due to the high temperature of the charge, owing to the hot blast. The metal, owing to its high temperature, is exceedingly fluid and this permits of successfully running thin, or intricate castings.

Some remarkably small and thin castings have been made, such as goblets, plaques, air hose couplings, motor cycle hubs, radiator brackets, etc. The thickest metal in the goblets was only 1-16 inch, and the thickness of the metal in the bracket, which was a long casting, was only 3-16 inch. The reproduction of the fine tracery on the plaques was especially noticeable. The carbon in all these castings was as low as 0.2 per cent.

The Converter.

The vessel is lined with ordinary silica bricks and is mounted on trunnions, which are fastened to a steel base plate which rests on a roller path in a cast iron plate. This arrangement forms a turntable whereby the mouth of the converter can be turned in any desired direction. In Fig. 4 the mouth of the vessel is turned toward the charging floor, and in Fig. 3, towards the ladle pit. The blast is supplied by a Root blower having a capacity of 3,000 cubic feet per minute. This blower is direct-driven by a 100-horsepower, 220-volt, 600-revolutions per minute, direct current motor. The blowing pressure varies from ¾ to 3½ pounds per square inch. The blast enters by a main passage through the center of the bottom plates, as shown in Fig. 2, and passes to a vertical blast main outside the converter, which conveys it to one of the trunnions, through which it passes to the blast box at the side of the converter.

The oil burners, which are removable, are located inside of the blast box. The oil is introduced by means of a set of seven small steel tubes, each having an internal diameter of about 1-16 inch. These tubes are centered in the blast pipe, and in this way the air and oil are intimately mixed. Crude oil is used, which costs, in England, about five cents a gallon. At this plant it is stored in a large underground tank, from which it is forced into a smaller tank, which contains sufficient oil for five or six heats. This service tank is equipped with a steam coil to thin the oil in cold weather. A small, independently-driven air compressor is connected to this tank and maintains a constant pressure of from 30 to 35 pounds per square inch on the oil, and forces it through a flexible tube to the tuyere box.

Combustion is started in the converter, when cold, by means of lighted waste, but after the lining has absorbed heat from a previous charge, the oil ignites itself. When the charge is melted, the oil pipes are withdrawn. The vessel is tilted by a direct-coupled, enclosed, 10-horsepower motor, which is carried in one of the trunnion housings. The turntable is also operated by a motor of similar capacity and design, but in this case through an intermediary shaft and bevel gear.

The converter is inclined to a horizontal position when charging, and is

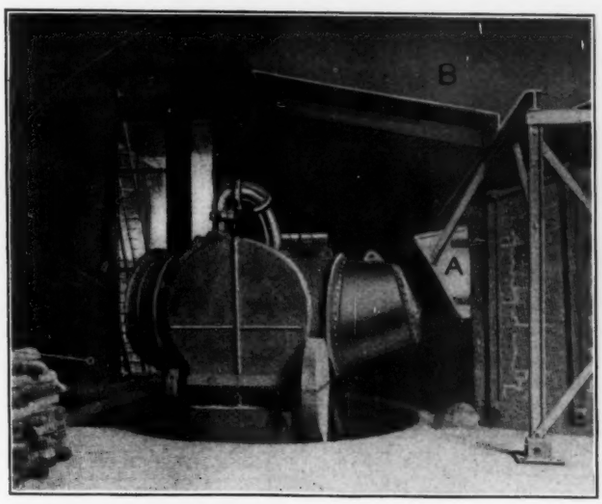

FIG. 1—THE CONVERTER IN MELTING POSITION; THE ECONOMIZER HOOD IS SHOWN AT *A* AND THE BLOWING HOOD AT *B*

FIG. 2—THE CONVERTER IN BLOWING POSITION, SHOWING THE METHOD OF INTRODUCING THE BLAST

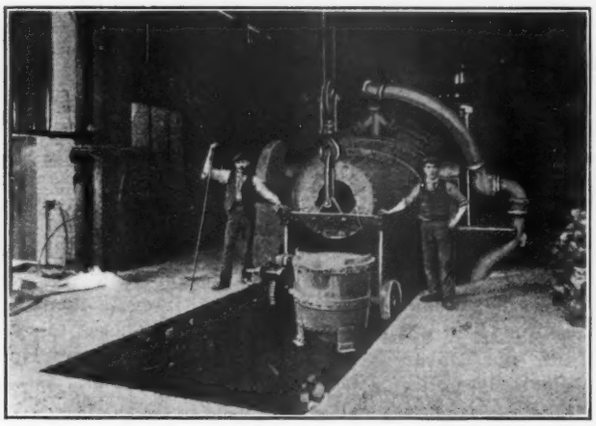

FIG. 3—THE CONVERTER IN POSITION FOR TEEMING THE STEEL

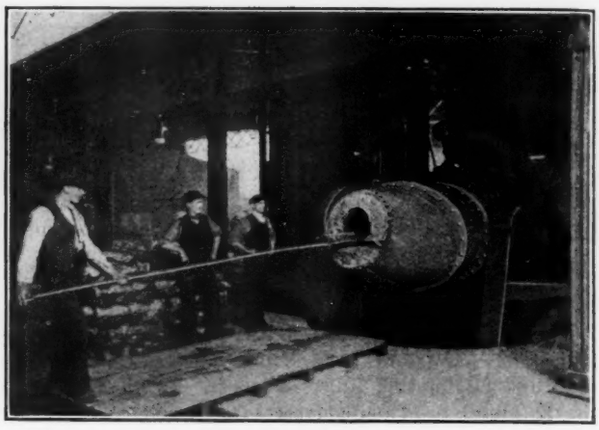

FIG. 4—POSITION OF THE CONVERTER WHEN CHARGING

turned toward the charging floor. The charging is done as shown in Fig. 4, and a full charge of pig iron and scrap can be put into the converter by three men in less than eight minutes. After being charged, the vessel is turned, until its mouth points into the small hood *A*, Fig. 1. This hood opens into an economizer, which is an important feature of the installation, as it recovers part of the waste heat that is produced during the melting operation. The economizer, Fig. 5, consists essentially of a series of ribbed cast iron pipes of U-section, arranged in a brick structure lined with fire brick. The blast for the converter forces through these pipes, while the products of combustion, issuing from the converter, circulate around the pipes before passing into the stack. By this arrangement the blast is heated to a temperature of about 570 degrees Fahr., before passing to the converter. The vessel, when melting, is maintained in a horizontal position, and this operation, using a 3-ton converter, requires about 1½ hours. As soon as the metal is melted, the valve controlling the oil supply to the pressure tank is closed, and the pump, which runs continuously, delivers to the main storage tank during the stoppage. The burners are then removed from the blast box, the vessel is turned into an upright position, and blowing proceeds in the ordinary manner, the gases passing off through the large hood, *B*, Fig. 1. The pressure of the blast, which was 12 ounces for melting, is now increased to 2½ or 3½ pounds. The blowing process lasts 20 minutes, when the vessel is swung to the charging position and the usual additions of ferro-silicon or ferro-manganese are made. After this the vessel is turned for teeming into the ladle, as shown in Fig. 3. A second converter has been installed in this plant so that repairs and renewals of linings may be made without interfering with the steel manufacturing operation. One converter has been operated continuously for 20 months, producing four heats per day. In practice, it has been found possible to obtain from 25 to 30 heats before renewing the lining.

In one heat, under observation, the charge of 2½ tons was melted and converted in 1¾ hours, with a fuel consumption of 70 gallons, and a power consumption of approximately 50 kilowatts, and, as the test was taken early on a Monday morning, it is reasonable to presume that still better results would have been obtained with a hot converter.

An average analysis of the steel taken from seven heats, follows: Carbon, 0.22 per cent; manganese, 0.572 per cent; silicon, 0.245 per cent; sulphur, 0.015 per cent, and phosphorus, 0.023 per cent. The average tensile strength per square inch was 63,000 pounds, elongation in three inches, 31 per cent, and reduction of area, 52 per cent. A carbon tool steel has been made containing carbon, 0.83 per cent; manganese, 0.072 per cent; silicon, 0.011 per cent; phosphorus and sulphur, 0.011 per cent. The Stock process

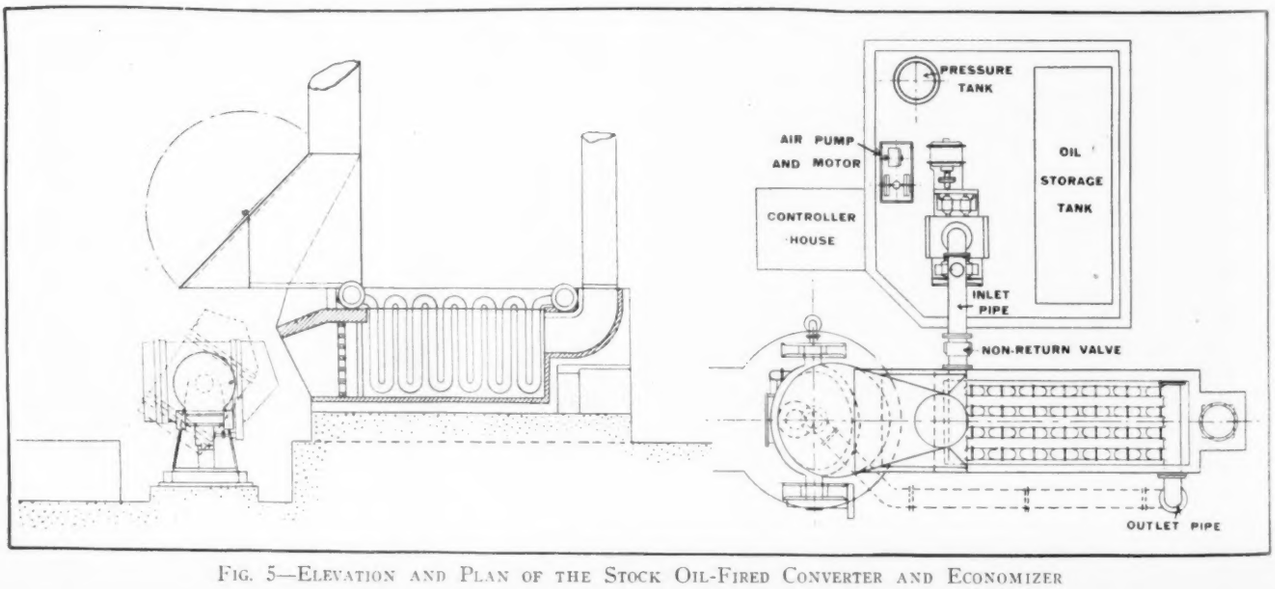

FIG. 5—ELEVATION AND PLAN OF THE STOCK OIL-FIRED CONVERTER AND ECONOMIZER

has been used also for the production of high speed tool steel containing carbon, 0.627 per cent; manganese, 0.198 per cent; silicon, 0.059 per cent; phosphorus, 0.002 per cent and sulphur, 0.007 per cent. A very low carbon steel which withstood all the admiralty tests has also been made, the percentage of carbon being 0.08 per cent; manganese, 0.18 per cent; silicon, 0.011 per cent; phosphorus, 0.011 per cent, and sulphur, 0.01 per cent. A remarkable feature of the castings is their delicacy of outline, freedom from blowholes and other defects. A wheel, 4 feet, 9 inches in diameter, cast from converter steel, was dropped edgewise on a steel ingot from heights of five, 10, 15 and 20 feet, without showing signs of fracture. A drop of 40 feet on the rim broke one spoke. After this, four more drop tests from a height of 40 feet were made, but caused no further fracture, either to the rim or the spokes, and the wheel was finally broken by a three-ton steel ball, which was dropped 10 times from a height of 40 feet.

The cost of producing steel by this process is given in the accompanying table, which is based on a production of 52 tons per week, working single shift only. It should be stated that the electric power is charged at a lower price that at which it could be obtained from a central power station. On the other hand, the cost of fuel is conservatively given, both in regard to the price and quantity consumed.

The cost of steel produced by a 3-ton Stock converter, on a production of 52 tons per week, working single shift only, using hematite iron at $14.70 per ton, the loss of metal during conversion being 13 per cent, with a further loss of 3½ per cent in ladle skulls and floor scrap, etc, follows:

2,670 pounds of metal	$17.19
40½ gallons of oil at 5 cents per gallon	2.03
Electric power, 42 units at 1 cent per unit	.42
Direct wages	.75
General repairs and upkeep, including linings	1.72
Cost of converted metal	$22.11
Allowance added for ladle linings and repairs	.49
Cost of metal in molds	$22.60
Allowance for depreciation and interest	.53
Royalty charges	.82
Total cost	$23.95

These figures, although obtained from carefully tabulated tests, must be considered as approximate, and would no doubt vary in each particular case.

The Stock oil-fired converter is handled in the United States by Charles S. Powel, 165 Broadway, New York.

Instructions for the Use of Boron in Copper

For making solid copper castings of high conductivity, the use of boron is now advocated. This element is closely related to carbon and is found in the same forms, namely the crystalline, in which it resembles the diamond, the graphitic, resembling graphite, and the amorphous condition, which is analogous to charcoal. In this latter condition boron has a greater affinity for oxygen than charcoal, and a relatively small quantity added to molten copper will remove the dissolved oxygen. The advantage of using boron for this purpose lies in the fact that, like charcoal, it does not combine with the red metal and any excess will float on the top of the metal bath. Therefore, the resulting castings are as pure as the original copper and of the same conductivity so that if copper of a high degree of purity is used, a high degree of electric conductivity is obtained in the castings. It follows, therefore, that amorphous boron is a desirable product for the brass founder. Unfortunately, it is difficult to prepare. It is also an unstable chamical and exceedingly combustible, taking fire when heated only by the sun's rays. The pure amorphous boron cannot be obtained, but it has been found that when mixed with its oxide, boracic acid, and other substances used in its production, the mixture can be employed in the proportion of one per cent to produce solid copper castings. This mixture has received the name of *boron flux* or *boron suboxide* and is a granulated, reddish gray powder.

Use of Boron.

The following instructions for its use have been issued by the General Electric Co., Schenectady, N. Y.:

A good grade of copper must be used. If the highest conductivity is desired, copper of the grade known as wire bar must be used, rather than the ordinary casting copper which may be inherently of low conductivity, by reason of its less degree of purity. Copper should be melted, as far as possible, out of contact with the air, and to this end, it should be covered with a thick layer of charcoal, ground to about ½-inch mesh and smaller. The copper, when molten, must be considerably superheated to a temperature not less than about 1,300 degrees Cent., when the boron flux may be added in the crucible. The flux must be carried in a container to the bottom of the crucible and well stirred into the copper. If the copper has been sufficiently superheated so that the boron flux may react properly, the surface of the copper will be turned to a bright, sky blue color. This point may be determined by holding the bed of charcoal to one side sufficiently to uncover a small portion of the molten copper. When the reaction has taken place, the copper may be allowed to stand, still covered by the charcoal, until in the judgment of the foundrymen, it is cooled to the proper temperature for pouring. This lowering of temperature may be expedited by the addition of small quantities of pure copper which has previously been purified by the boron flux. Risers may be used for this purpose.

How to Add Boron.

A convenient way to add the boron flux is to enclose it in an envelope made up of sheet copper about 1-72-inch thick, the sheet being folded up and tied with copper wire to a carbon or graphite stirring rod. The rod, so as to not be too easily broken, should be about 1½ inches in diameter. The rod, carrying the copper envelope on its end, may then be thrust into the molten copper, carrying the flux to the bottom and it may then be well stirred in by the carbon rod. Care must be taken not to expose the copper surface to the air any more than is absolutely necessary, because molten copper will absorb oxygen very rapidly, and thereby its conductivity will be greatly lowered. The boron flux should be kept in tightly stoppered bottles, out of contact with the air, to prevent any absorption of moisture and the flux is used in the proportion of one pound of flux to each 100 pounds of copper melted, when ordinary sand castings are to be made. When castings are to be made in metal molds, the proportion of flux to copper may be reduced. The shrinkage of pure copper is considerable; therefore, the castings must be fed by large gates and large risers. Practice in this respect should be about the same as that in the casting of manganese bronze.

Contraction of the copper castings is about the same as that of manganese bronze, and allowance should be made accordingly in patterns. In handling the boron suboxide care should be taken to expose it as little as possible to the atmosphere and when it is not in use the material should be kept in a tightly corked bottle.

THE BRASS FOUNDRY

A Well-Equipped Jobbing Brass Foundry

PROBABLY the most important points to be considered when designing a building to be used as a brass foundry, are light, heat and ventilation. The first of these is readily provided by an abundance of windows, and constitutes an obvious economy which continues as long as the building is used. Numerous windows, therefore, should be considered an essential feature of such a building, as daylight is cheaper and is to be preferred to artificial light.

Heat and ventilation, however, conflict to some extent, and one or the other is liable to be sacrificed in cold weather. To obtain ample ventilation demands a high roof with numerous openings through which the fumes and gases can quickly escape. The economy of a comfortably warm foundry is more obvious in cold weather than good ventilation, for when the temperature falls so low that gloves and extra clothing must be worn, the output of the shop immediately suffers. Consequently, it is not uncommon for the ventilation to be neglected in brass foundries in cold weather, especially in shops with low roofs. Poor ventilation in brass foundries is highly injurious to the health of the workmen and the employer who is interested in the welfare of his employes, will give the subject of ventilation careful consideration when laying out his shop. In addition to ample light and ventilation, it is a distinct advantage to make the surroundings of the shop as pleasant and orderly as circumstances will permit.

Layout of the Plant.

When the new foundry of the Comstock-Wellman Bronze Co., Cleveland, was erected the problems of ample light, heat and ventilation were given careful consideration. The plant is located on Superior avenue and Sixtieth street, in the center of a residential district, and consists of a foundry building, 60 x 110 feet, of brick and steel construction, a detached office building, also of brick, and a pattern and sand-storage building. The general arrangement of the plant is shown in the plan view, Fig. 1. The office building is erected at one end of the foundry, and faces the street. The plot of ground between the office and the end of the shop is grass-covered and is dotted with shade trees and flower beds. This space is enclosed with a neat iron fence. A tree-shaded lawn also extends from the office to the street, and the effect produced by this arrangement of buildings and touch of nature is very pleasing, and constitutes a great improvement over the usual practice of filling all the available space around a foundry with a disorderly array of old flasks—rusty keepsakes of past operations. All the dirt and debris incident to foundry operations are confined to the yard in the rear and cannot be seen from the street. The location of the office in a separate building also possesses desirable features, inasmuch as it can be kept much cleaner than when attached to the foundry.

Abundance of light is provided in

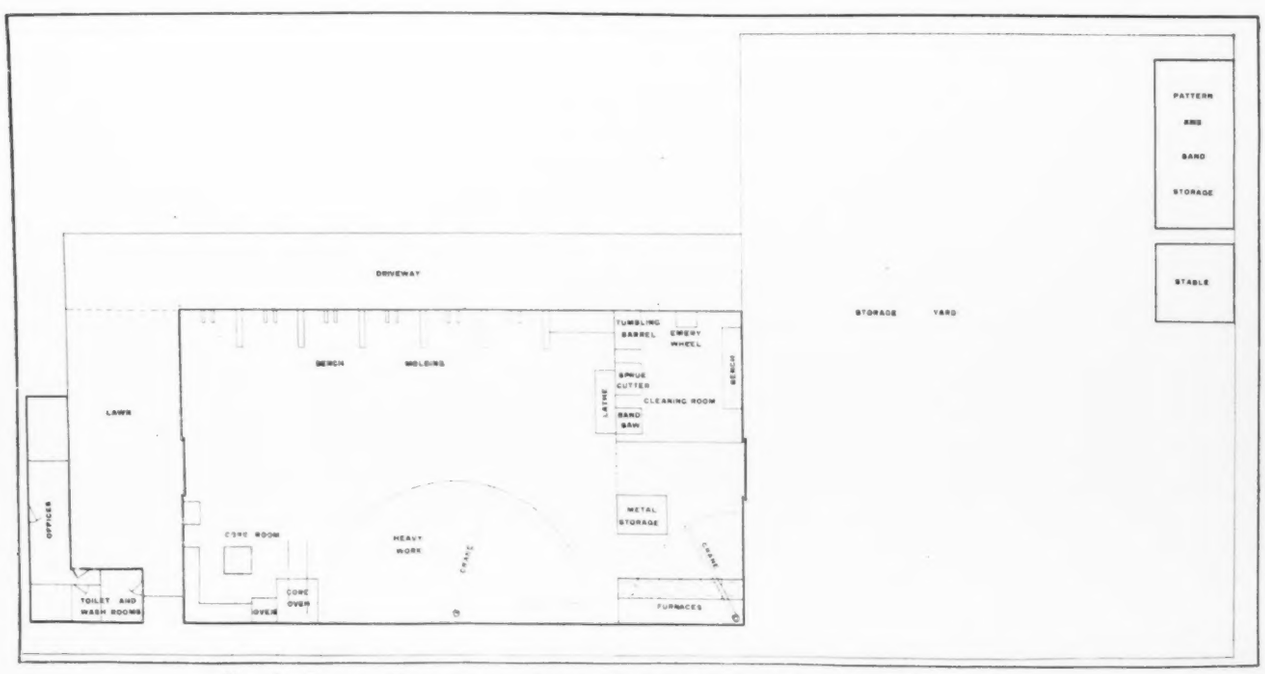

FIG. 1—GROUND PLAN OF THE BRASS FOUNDRY OF THE COMSTOCK-WELLMAN CO.

FIG. 2—A WELL-VENTILATED BRASS FOUNDRY AND METHOD OF DISTRIBUTING THE WASTE HEAT FROM THE FURNACES

this foundry by means of the large windows, shown in Fig. 3, which are placed so close together along the sides of the shop that they practically form one continuous window. The only brickwork interposed are the pillars which carry the roof trusses. The side walls of the foundry have been carried up sufficiently high to give ample head room, and the high roof is surmounted by a monitor which extends the entire length of the shop, as shown in Fig. 2. The monitor is equipped with continuous swinging sash which can be opened and closed by chains which hang to within reaching distance of the foundry floor. Thus, the two essentials of light and ventilation are well provided for in this foundry, and in addition, the exterior has been so beautified that the entire plant harmonizes with its surroundings.

Heating the Shop.

The problem of heating a shop of this size is a serious one and to the cost of heating these plants can be attributed the numerous brass foundries with low roofs. In this foundry the heating problem has been solved in a highly ingenious manner by utilizing the waste heat from the furnaces. A view of the heating apparatus is shown in Fig. 2. It consists of a sheet steel hood which almost entirely encloses the furnace flue. To the upper part of the hood is attached a pipe, three feet in diameter, which connects with the main hot air distributing pipe. This pipe extends to the center of the shop where it is connected at right angles to another pipe. This pipe extends the length of the shop, and is provided with outlets as shown at A, Fig. 2. The diameter of the main air pipe is contracted just beyond each

FIG. 3—VIEW OF MOLDING FLOORS FOR LIGHT WORK, AND ARRANGEMENT OF WINDOWS IN THIS WELL-LIGHTED BRASS FOUNDRY

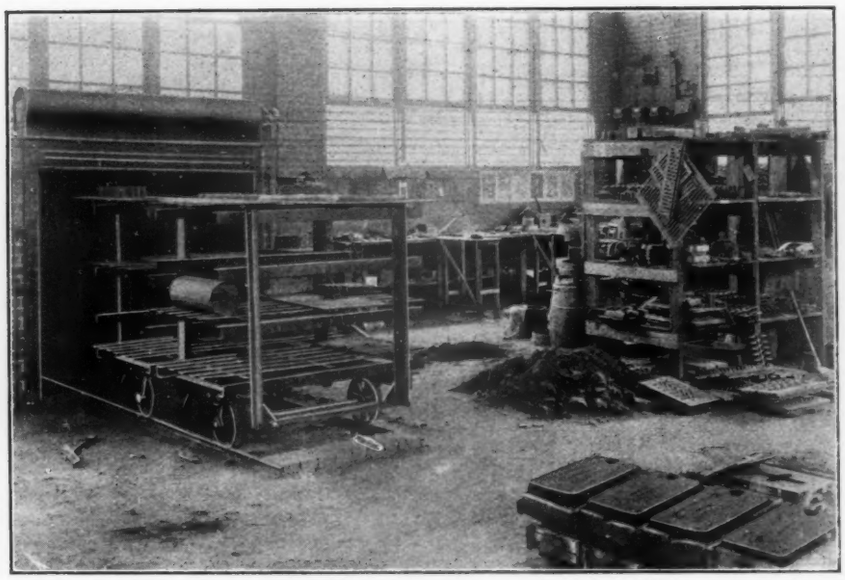

FIG. 4—CORE DEPARTMENT, SHOWING THE CORE OVEN AND CAR

pair of openings, until it becomes an 18-inch tube at the end farthest from the furnaces. Provision has been made, also, for an extension to the heating system in the opposite direction when the shop is enlarged. The circulation of the hot air through the pipes is facilitated by a fan enclosed at B, Fig. 2. Above the fan an opening is provided in the pipe through which hot air is deflected during the summer months. To confine the heat of the furnaces underneath the hood, the furnace covers in winter are opened at night, and a sheet extension of the hood is fitted over them. The furnaces are thereby entirely enclosed by the hood and the heat is carried upward and is distributed throughout the shop. While this waste furnace heat will not entirely heat the shop in severe weather, because the fires die out at about midnight, it is sufficient in the day time when the full equipment of furnaces is in operation. The installation of natural gas burners underneath the hood is contemplated to continue the heating of the shop after the furnace fires are low.

Furnace Equipment.

The furnaces are of the coke-burning, crucible type, and were installed by the J. D. Smith Foundry Supply Co., Cleveland. A Steele-Harvey tilting crucible furnace, installed by the Monarch Engineering & Mfg. Co., Baltimore, of 800 pounds capacity, is also being installed. The metal is lifted from the furnaces by the aid of a wall crane equipped with a crucible lifting lever attached to a trolley, as shown in Fig. 6. The space underneath the hood can be utilized, to a limited extent, for the storage of crucibles and forms a convenient place in which to anneal the reserve crucibles.

A view of the floor for heavy work is shown in Fig. 7. A jib crane equipped with a one-ton Triplex block, manufactured by the Yale & Towne Mfg. Co., New York City, serves this floor. The crane was installed by the Euclid Crane & Hoist Co., Euclid, O. The mast is braced as shown at C, Fig. 7. The metal storage department is partitioned off from the rest of the shop and consists of a low building adjacent to the furnaces, as shown in the plan, Fig. 1. This enclosure is fitted with shelves, bins and partitions for the various metals and with scales for weighing the mixtures.

The class of castings made covers a wide range and includes aluminum sections for the automobile trade, manganese-bronze and castings from special mixtures. All kinds of jobbing work is handled, and the shop equipment permits heavy castings to be made. The casting cleaning department is divided off from the rest of the shop, as illustrated in Fig. 2. The cleaning equipment consists of a tumbling barrel, sprue cutter and band saw installed by the J. D. Smith Foundry Supply Co. The castings are ground by an electric grinder installed by the Hanson Mfg. Co., Oshkosh, Wis. A view of one corner of the cleaning room is shown in Fig. 5. The equipment is belt-driven from a countershaft operated by a motor.

Molding Floor.

A view of the bench molding floor is shown in Fig. 3, which also illustrates the arrangement of the windows. In this foundry, benches are used in place of brass molders' tubs. One reason for this is that some of the benches are fitted with squeezers for making the smaller castings. Snap flasks are largely used, especially for small bench work, and the molds are stacked for pouring. Wooden jackets are used around the snap molds, and instead of top boards, cast iron plates are used on top of the molds, as shown at D, Fig. 3. These plates facilitate stacking the molds, as they are provided at one end with a circular opening which has a beaded edge on the curved side. This opening encircles the sprue of the mold, and the raised edge confines any metal that may overflow, while the entire top of the mold is covered with the plate.

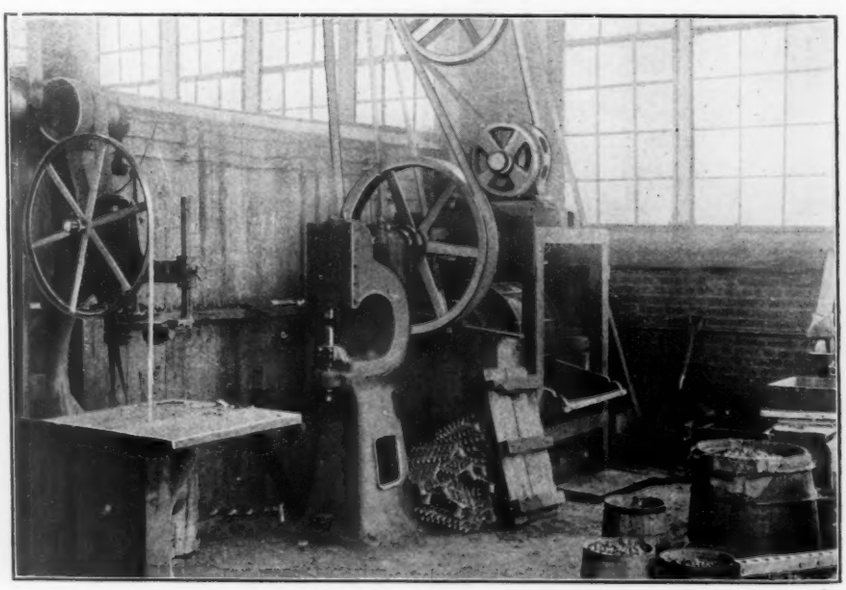

FIG. 5—CASTING CLEANING DEPARTMENT, SHOWING THE TUMBLING BARREL, BAND SAW, SPRUE CUTTER AND MOTOR

The side windows of the shop are placed at a considerable height above the floor. This insures a better distribution of light toward the center of the shop than would be the case if the windows were placed lower down. In Fig. 4 is shown a view of the core department, which is located in a corner of the shop opposite the bench molding floor. The large core oven is of the roller door type and was installed by the J. D. Smith Foundry Supply Co. In the corner back of the large oven, a smaller oven is located. This oven is of the hinged drawer type and is used for baking small cores.

An admirable feature of this shop is the brick floor which is laid in cement. The floor is level and as all the crevices between the bricks are filled with cement, any metal that is spilled can be easily recovered. A good floor is of great importance in a brass foundry as the small particles of brass that are scattered about can be easily recovered instead of being trampled into the earth. A hard, level floor also saves much time in preparing the molds for casting. Thus, a continuous saving of time is effected that would otherwise be expended in wedging under the cleats of the bottom boards. The wash room is located in the office building. Every reasonable convenience for the comfort of the employes has been provided.

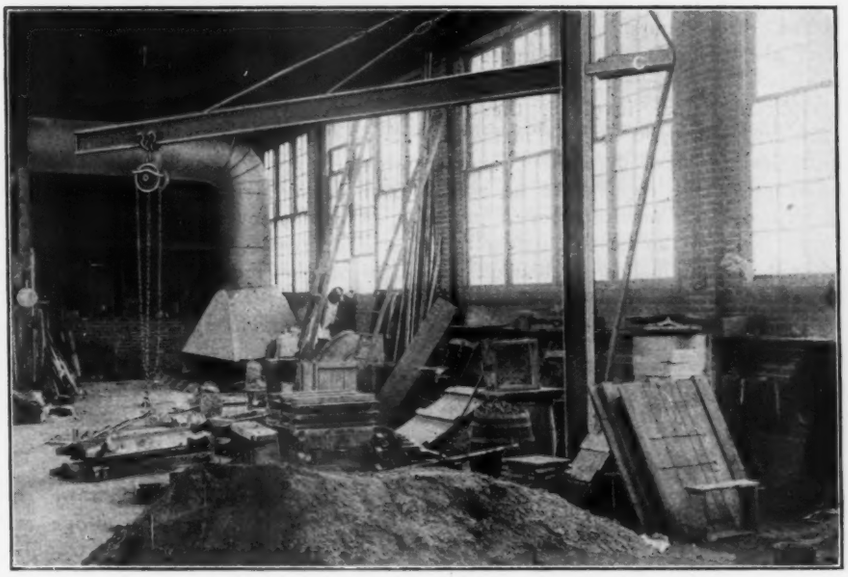

FIG. 7—HEAVY WORK FLOOR, SHOWING THE JIB CRANE AND FURNACES IN THE DISTANCE

New Method of Alloying Aluminum

An improved process for the manufacture of aluminum alloys has been recently patented by J. G. & W. F. Mellen, Bridgeport, Conn., who claim to be able to produce a more malleable and ductile alloy than by ordinary means. In making an alloy of copper and aluminum, the copper is first melted and the aluminum alloyed therewith, after which an oxidizing agent is added with a flux, the effect of which it is stated is to produce an intimate mixture of the component parts of the alloy, the failure to obtain which has been the cause of unsatisfactory aluminum alloys in the past. The flux recommended consists of one-half pound of bichromate of potash, intimately mixed with one-fourth pound of borax. This is added to 100 pounds of metal, and it is claimed causes a furious action due to the oxidation of the aluminum, which causes atomic and molecular activity, producing an intimate mixture of the metals. The borax dissolves the oxides as fast as they are formed, and it is stated that in this way the full benefit of the oxygen is obtained and the oxides are removed.

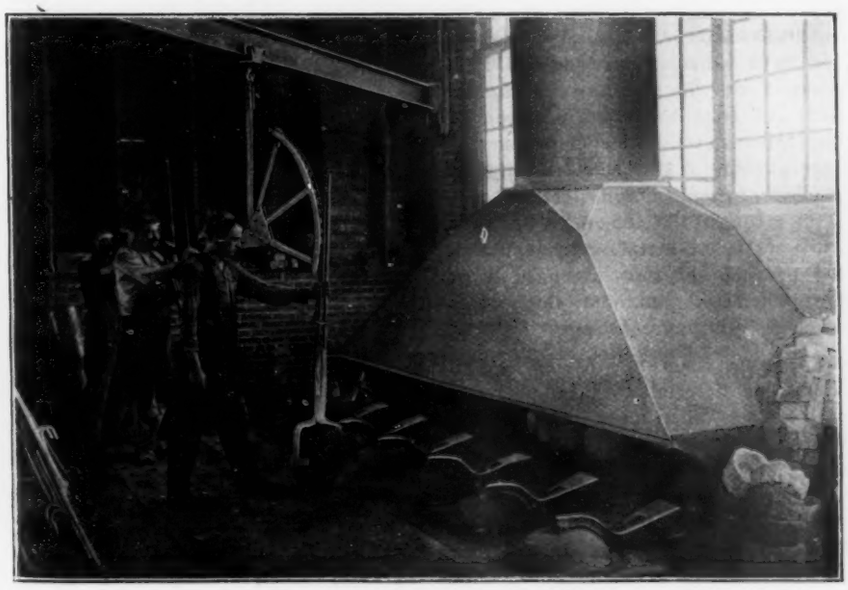

FIG. 6—A BATTERY OF BRASS FURNACES, EQUIPPED WITH A WASTE HEAT, HOT AIR HEATING SYSTEM

Melting Copper in an Electric Furnace

The melting of non-ferrous metals in an electric furnace is discussed by Chas. A. Weeks in *Metallurgical and Chemical Engineering*. The author reported the results of copper, monel metal, brass and bronze melting tests with the use of an electric furnace as the melting medium. The furnace had a capacity of three tons of copper and radical steps were taken to prevent the volatilization of the metals which would occur with the ordinary type of arc furnace. To prevent the burning of the metal, the heat was transferred to the metal from the arc by radiation, together with some reflection and conduction from the walls and roof of the furnace. The furnace was entirely closed and was as simple to operate as an open-hearth furnace. A number of runs were made on melting copper scrap, melting charges of 2,000 pounds. To melt this amount of metal and to superheat to a temperature above 1,600 degrees Cent. from a cold furnace, required 600-kilowatt hours and the metal was poured in 3½ hours. The loss of copper with a new furnace lining was less than 1 per cent. To melt another charge of 2,000 pounds to a temperature of 1,200 degrees Cent. required 500-kilowatt-hours and re-

quired three hours. When starting with a hot furnace these figures are considerably reduced. As no slag complications are involved, the furnace can be tapped into as many receptacles as desired without power interruption, the copper can be poled at will and the resulting tough pitch copper kept in the furnace indefinitely without oxidation, as a blanket of charcoal is kept floating on the metal to protect it from such slight amounts of air as may enter a practically tight furnace.

The figures given for copper apply also to the melting of monel metal, the proper pouring temperature of which is approximately 1,400 degrees Cent. The melting of this metal in open-hearth, reverberatory or crucible furnaces results in the serious oxidation of the metal. This trouble is avoided when the metal is melted in a non-oxidizing electric furnace.

Alloys of Brass and Bronze*

By Percy Longmuir

NOTWITHSTANDING the variety of products in brass foundry practice, the underlying principles are common throughout, and, although the types of alloys vary, two stand out prominently and to a certain extent represent the whole. These two alloys are standard yellow metal and standard gun metal, the first containing copper, 70 per cent, and zinc 30 per cent, and the latter, copper, 88 per cent; tin, 10 per cent, and zinc, 2 per cent. The question of oxidation is of vital importance and is associated with many of the difficulties encountered. Thus, the addition of cuprous oxide up to 3.5 per cent lowers the freezing point of copper, while beyond this amount it has the curious effect of raising the freezing point. The pure metal solidifies at 1,084 degrees Cent., and with 3.5 per cent of cuprous oxide, the freezing point falls to 1,065 degrees Cent. These features have a direct, practical bearing on the resulting properties of the alloys, as whenever oxygen is absorbed by the metal while in the molten state, its malleability, when cold, is affected by the quantity of oxide that is retained.

Deoxidizing Copper.

The removal of oxygen from copper is only accomplished to a limited extent by charcoal placed on the surface of the molten metal, as it only comes in contact with a relatively small portion of the metal; but if the charcoal is held at the bottom of the crucible, it will effectively deoxidize the copper. In addition to charcoal, other deoxidizing agents include phosphorus, silicon and manganese, which, when introduced into molten copper, permeate the mass of the metal and combine with the oxygen to form oxides which rise to the surface.

German silver is deoxidized by manganese and cannot be satisfactorily produced without that metal owing to the absorption of oxygen by the nickel. Copper and zinc alloys are not so subject to oxidation troubles as bronze, owing to the fact that the zinc acts as a deoxidizer for the copper. In the case of bronze, both the tin and the copper unite with oxygen, and the oxides are retained in the alloy and do not rise to the surface. Metallic tin will reduce copper oxide, but the oxygen is not eliminated, being held by the alloy as tin oxide.

Zinc Losses.

In melting alloys of copper, tin and zinc, which are used so largely, the losses caused by oxidation of the zinc, are often considerable, and are due to the union of the zinc with the oxygen dissolved by the copper, and to the volatile nature of the zinc. An alloy of copper, 70 per cent, and zinc 30 per cent, produced castings that contained only 24 per cent of zinc. The loss of zinc is not determined by the amount that the alloy may contain. In the case of a gun metal containing 1.8 per cent of zinc in the finished castings, the loss was 27.7 per cent when heated to 1,173 degrees Cent. A red brass containing 10.2 per cent lost 28.6 per cent of the latter metal, when heated to 1,308 degrees Cent. A yellow brass containing 26 per cent zinc lost 26.1 per cent at a temperature of 1,182 degrees Cent., while a Muntz metal which contained 40.5 per cent of zinc lost only 19 per cent when the maximum temperature reached 1,038 degrees Cent.

The exact working losses of zinc should be determined in the case of each alloy. When manganese or phosphorus is added to an alloy, heavy losses of these constituents occur, the amount varying considerably, but averaging, usually, from 30 to 50 per cent. This, however, is only of secondary importance as their chief function is the elimination of oxygen, and it may occur that all the manganese or phosphorus is used in this scavenging process, and none remains in the casting.

The speed of melting is also an important factor. The metals should be melted as quickly as possible, and should never be allowed to remain in the furnace in a molten condition longer than necessary.

Alloys of Copper and Tin.

The alloys of copper and tin, with the exception of bell metal, are not extensively used. The composition of bell metal follows: Copper, 83.3 per cent, and tin, 16.7 per cent. The copper-tin-zinc alloys are largely used under the name of gun metals, machine brasses and valve metals. An example of these alloys is standard gun metal which has a maximum tensile strength of 40,320 pounds per square inch, and an elongation in 2 inches of 11 per cent. It is generally conceded to be the best gun metal mixture. Another alloy contains 86 per cent of copper, 4 per cent of zinc and 10 per cent of tin. It is not quite as strong as the standard alloy. A third alloy, old admiralty gun metal, could be made to give as good results as the standard alloy. Its composition follows: Copper, 87 per cent; tin, 8 per cent; and zinc, 5 per cent. The specifications issued by the British admiralty require a tensile strength of 31,360 pounds per square inch, for the 88-10-2 mixture, with an elongation of 8 per cent.

These results are not always obtainable, however, for in the course of hundreds of tests variations in the tensile strength from 14,560 pounds to 44,800 pounds per square inch were noted, with variations in elongation from 3.7 to 16 per cent. The composition of the alloy in each test was identical. The machining properties of alloys are improved by the addition of lead, owing to the fact that it is distributed throughout the alloy and destroys its continuity. Tin should not be present in quantities exceeding 10 per cent if safety is of importance, except in the case of bearings. Beyond 14 per cent, tin produces a hard and brittle alloy, an example being an alloy of the following composition: Copper, 85 per cent; tin, 13 per cent, and zinc, 2 per cent. The alloy has a maximum stress of 11.9 tons per square inch and an elongation of only 1.5 per cent.

Phosphorus is used to impart hardness in the case of bearing metals. At one time phosphor bronze was extensively used for underground water fittings, but it has been largely supplanted by steel. The chief factors that influence success in the production of alloys are freedom from chemical impurities in the composition,

*From a paper presented before the London, Eng., branch of the British Foundrymen's Association.

correct methods of molding and melting, pouring at the proper casting temperature and avoidance of shrinkage defects by the adoption of correct methods of feeding.

New Aluminum Alloys

The new alloys of aluminum which are claimed to be non-corrosive have been made the subject of a patent in Great Britain by G. Jacquier, of Johannesburg, South Africa. The proportions recommended by the patentee are as follows:

	Per cent.
Aluminum	92
Copper	5
Bismuth	2
Silicon	1

The silicon is introduced in the form of a high percentage silicon-copper and the amount of copper which is introduced with the silicon is deducted from the 5 per cent of copper that is introduced. The copper is first melted, the silicon-copper is added, followed by the bismuth and lastly the aluminum, care being taken not to add the latter too quickly, otherwise the melted copper will be chilled.

The second alloy recommended is as follows:

	Per cent.
Aluminum	91
Copper	5
Bismuth	2
Magnesium	2

In making the latter alloy, the best manner in which to add the magnesium is after one-half the aluminum has been added to the copper. The metal is brought to a red heat at this stage, the magnesium is added in small pieces, followed by the balance of the aluminum. This will cool the alloy to any desired casting temperature.

Magnetic Properties of Heusler Alloys

A detailed description of the methods adopted and the results obtained in an investigation of the magnetic properties of Heusler alloys, conducted by Edward B. Stevenson, are given in a bulletin, recently issued by the engineering experiment station of the University of Illinois. The Heusler alloys consist of copper, manganese and aluminum, and are remarkable in that, in certain proportions, they are ferro-magnetic, although the component metals are not ferro-magnetic. These alloys were accidentally discovered in 1901 by Dr. Heusler, who while turning certain manganese alloys in a lathe, noticed that the turnings adhered to the tool. This discovery led to a general investigation of the magnetic properties of manganese alloys, and it was later found by Dr. Heusler, W. Stark and E. Haupt that a copper-manganese alloy was not itself magnetic, but that when mixed with zinc, arsenic, antimony, bismuth, or boron, it was more or less magnetic, and when aluminum is added, a good ferro-magnetic alloy is obtained. The most magnetic alloy, it was discovered, was formed when the manganese and aluminum were in the proportion of their atomic weights, as follows: Manganese, 25 per cent; aluminum, 12.5 per cent and copper 62.5 per cent. The tests described in the bulletin confirmed the fact that the most magnetic alloy was one that came nearest having the individual elements in the proportion of their atomic weights. The best alloy contained copper, 64.4 per cent; manganese, 23.4 per cent and aluminum 14.2 per cent. These alloys are of interest from a scientific point of view, in that they show that a magnetic material can be formed from a combination of non-ferrous metals. As might be expected from a consideration of their analysis, the metals are hard and brittle, and because of this fact their industrial application will, undoubtedly, be very limited.

Corrosion of Spelter Solder

A PAPER presented by Professor H. Louis, at the annual meeting of the Institute of Metals, Newcastle-on-Tyne, Eng., described the failure of a brazed joint of a steam pipe on a steamship, which was due to the corrosion of the spelter solder. The copper pipe was 5½ inches in inside diameter, and at the time of the explosion was under a steam pressure of 175 pounds. The braze was a bevelled joint which extended longitudinally and had opened a distance of 3 feet, 6 inches. The joint was found to be badly corroded. The composition of the spelter solder used to make the joint follows: Copper, 27 pounds; zinc, 24 pounds, and tin, four ounces; this corresponds, in percentages, to copper, 52.68 per cent; zinc, 46.83 per cent; tin, 0.49 per cent.

An inspection of the pipe developed the fact that the outer portion of the joint, for about half its length, was sound, retained its yellow color and was to all appearances unchanged, while the inner portion had been considerably corroded and had become a copper color and could be easily broken or detached from the tube. Numerous cavities and fissures were found which apparently contained basic salts of copper and zinc. An analysis of the sound portion of the brass gave the following results: Copper, 66.60 per cent; zinc, 31.30 per cent; tin, 0.77 per cent; lead, 0.40 per cent; arsenic, antimony and iron, trace.

The corroded portion was found to contain copper, 78.40 per cent; zinc, 13.50 per cent; tin, 0.78 per cent; lead, none; arsenic, antimony and iron, trace; oxygen and loss, 7.32 per cent. Microscopical examination of the brazing solder showed that the crystals of the metal were separated by a fine network of white alloy and all the fissures and fractures of the corroded brass followed these lines. Therefore, it was obvious that these white lines formed lines of weakness along which corrosion had taken place, and it became apparent that if it were possible to prevent the recurrence of these lines of defect, corrosion could largely be prevented. To determine the cause of this reticulated structure a series of alloys was made, as follows:

A.—Pure brass containing two parts of copper to one of zinc.

B.—Same as A, with the addition of 0.75 per cent of tin.

C.—Same as A, with the addition of 0.5 per cent of lead.

D.—Same as A, with the addition of 0.75 per cent of tin and 0.5 per cent of lead.

Tests.

These alloys were etched, the same as the original brazing solder, with a 10 per cent solution of hydrochloric acid, and incidentally, the discovery was made that while the dilute acid has very little effect on brass, that by gripping the button of brass in close metallic contact between the jaws of a copper clip, the brass was attacked quite readily, and results strictly comparable to those of the original brazing were obtained. This method, which may be termed galvanic etching, will probably be found useful in many other cases.

All the trial alloys, when cooled, showed a fine-grained, crystalline structure, quite different from that of the original brazing. When annealed at 1,152 degrees Fahr. for 30 minutes, the typical brass structure was developed and there was no indication of segregation around the crystals of the pure brass. The same results were obtained by remelting under borax, followed by slow cooling, but the best results were obtained by remelting under charcoal and slowly cooling. By this treatment the pure the metals are hard and brittle, and be- brass did not reveal the white lines.

The white lines of weakness are, therefore, undoubtedly caused by the segregation of an alloy of lead and tin in the brazing solder. This alloy is more fusible than brass and solidifies around the crystals of this metal, forming planes of weakness which may yield under strain and permit liquids to penetrate into the mass of the metal. The liquids dissolved out the lead, a portion of the zinc and a small amount of the tin, which resulted in the disintegration of the brazing solder. It was evident that the lead was the injurious element. Tin appeared to be injurious only in the presence of lead. It was not determined whether or not 1.25 per cent of lead would do more harm than 0.5 per cent of lead and 0.75 per cent of tin.

The conclusion to be reached from this investigation seems to be that the purity of the metals used in making spelter solder that is exposed to the action of salt water, is of greater importance than has been supposed. The copper should be high grade and the zinc of the utmost purity to guard against the introduction of lead, as the presence of the latter may cause the deterioration of the solder.

Brass Foundry Difficulties

SOLVED BY EXPERTS

Cheap Valve Metals

We are making steam valves and cocks of a cheap metal. It machines well, but is not strong. We would like to know if there is any formula we could use that would be cheap and give greater strength. The formula we are using at present is as follows: Copper, 80 pounds; zinc, 12 pounds; lead, six pounds, and tin, two pounds.

The lead is the cause of the weakness of this alloy. If an increase of strength is desired, some lead must be omitted, and to avoid any increase in cost the zinc must be increased, thus practically producing a yellow brass. We suggest the following alloy: Copper, 75 pounds; tin, two pounds; zinc, 20 pounds, and lead, three pounds.

Nickel Bronze

We have a number of bronze gears to make and the metal specified is nickel bronze. We have had no experience with this alloy and would like to have you furnish us a formula and information as to how this alloy is made.

There is no standard nickel bronze alloy, and the term can be applied to any alloy of copper containing any quantity of nickel from a mere trace to several per cent. Therefore the specifications should have included the formula of the alloy. However, a tough, strong metal is undoubtedly required and a mixture that can be recommended, follows: Copper, 88½ pounds; tin, eight pounds; manganese-copper, ½ pound, and nickel, three pounds. Charge 40 pounds of the copper with three pounds of shot nickel, using charcoal liberally as a cover, and when melted add the manganese-copper to cleanse the metal of oxides that may have been produced by the high temperature to which the copper has to be raised in order to dissolve the nickel; then add several pounds of copper to cool the charge and then charge one-half the tin. The tin is added at this time to facilitate the addition of the remainder of the copper charge, as the melting point of the metal is lowered and the tendency to chill is decreased. The remainder of the copper charge is previously heated on top of the furnace and is added to the mixture in the crucible in such a manner as not to chill the metal already melted. When all the copper is melted, add the remainder of the tin and after stirring the contents of the pot thoroughly the metal is ready to cast.

Soft Yellow Brass

We have an order for yellow brass castings that must be extra soft to permit them to be easily machined with hand tools. What mixture would you advise? We would prefer to dispense with the use of zinc on account of the fumes and would rather use a copper-tin alloy, even if somewhat more expensive. Could you suggest such a mixture to meet the same conditions as the yellow brass?

A formula for a yellow brass that would meet the above requirements, follows: Copper, 66 pounds; zinc, 28 pounds; lead, 3½ pounds, and tin, 2½ pounds. As there are no means known, by which an alloy of a yellow color can be made without the use of zinc, there is no alternative but to use this metal in the mixture. However, if the color is immaterial, and a metal of a red color can be used, the composition of a suitable alloy is as follows: Copper, 83 pounds; zinc, 8½ pounds, and lead, 8½ pounds. This alloy is very soft, can be easily machined, and is extensively used for small brass castings that are finished on turret lathes. If an alloy of yellow color is indispensable, the annoyance caused by the fumes of zinc when casting yellow brass can be greatly modified by the addition of aluminum to the mixture. Such alloys are practically limited to small castings, on account of the difficulty caused by the dross produced by the aluminum. In case the castings are small and light, the following alloy would probably prove entirely satisfactory: Copper, 67 pounds; zinc, 30 pounds; lead, three pounds, and aluminum, two ounces. This alloy can be poured with the same freedom from smoke as most red brasses, and will run sharp castings at a low temperature, but is liable to run drossy and to shrink abnormally in heavy sections of the castings.

Speculum Metal

We would like to make speculum metal. Will you kindly advise us what you consider a good speculum metal formula?

Speculum metal is an alloy of copper and tin and contains more of the latter metal than bell metal. It is a white and very brittle alloy, nearly as hard as steel, that takes a beautiful polish and was formerly used for making mirrors. A good formula for speculum metal follows: Melt under charcoal, copper, 68 pounds; when thoroughly liquid, add 32 pounds of tin. The metal should be poured at as low a temperature as possible and the molds should be dried and coated with plumbago.

Bearing Alloy

An alloy for bearings, recently patented, is made approximately as follows: Aluminum, 79 per cent; magnesium, 11 per cent; copper, 9½ per cent, and phosphor-copper, ½ per cent.

A NEW CHILLED ROLL MAKING PROCESS

How air blast is utilized for chilling sheet and tin plate rolls--Detailed description of the flask

A NEW method of chilling sheet and tin plate rolls, whereby not only a uniform chill is obtained, but a surface is also imparted to the roll that is equal to that secured by water-chilling and, it is claimed, without any of the bad effects, such as internal strains, has recently been introduced in a foundry in the Pittsburgh district. This new and radical departure in roll foundry practice, which consists of utilizing air blast for obtaining the chill, is being practiced by the National Roll & Foundry Co., Avonmore, Pa., the process having been invented by J. B. Baird.

A water-cooled chill is so constructed that a stream of water constantly circulates through its interior, thereby cooling the chill when the molten metal comes in contact with its surface. The molten metal is thus instantly cooled on the surface of the roll and thereby chilled. The necks and wabblers are not chilled, but are cast in a sand mold and are left to gradually cool by radiating their heat through the sand surrounding them. There is a considerable difference in the rate of cooling between the neck and the body of the chilled roll and frequently internal strains result. The close-grained surface of water-cooled rolls is very much desired, particularly for the rolling of sheets, as this surface requires less polishing than the surface of a roll otherwise cast.

By the air blast process the rolls are cooled much more rapidly than when ordinary cast iron chills are used, but the molten iron is not chilled as rapidly as by the water-cooled process and, in addition, the rate of cooling can be controlled by the operator. Thus, the blast can be so controlled that the molten metal will set rapidly to obtain a good face on the roll, after which the cooling can be more gradual throughout the body of the roll to eliminate casting strains. In the ordinary chilled roll process the body of a roll is cast in an iron flask or chiller while the necks and wabblers are cast in sand molds. The surface of the chiller is covered with an extremely thin coating of graphite to prevent the metal from adhering to the mold. The heat of the molten metal is radiated more or less rapidly and the depth of chill obtained, depends, to a large extent, upon the nature of the iron used in the mixture. This chill is of a crystalline nature, the crystals forming at right angles to the chilling surface. The chill is extremely hard when formed, but the subsequent heating of the iron mold from contact with the still molten iron in the interior of the mold has an annealing effect on the surface of the roll whereby its hardness is reduced and the close grain originally formed is again opened. In water-chilled rolls this re-annealing effect of the face is prevented by the cool surface of the chill.

The flask used for the blast chilled roll process is hollow and in the space between the outer and inner molds air, under pressure, is continually forced. As the blast pressure can be increased or decreased it is apparent that the rate of cooling can readily be controlled.

In Fig. 1 is shown an assembled flask arranged to utilize the air blast for chilling the face of the roll. The blast pipe through which the blast enters is shown at *A* and the discharge opening for the heated air is illustrated at *B*. To ascertain the amount of heat that is being absorbed by the blast from the mold, a thermometer is placed in the exhaust opening. From this temperature and the blast pressure, the temperature of the cooling casting can approximately be obtained. This furnishes a guide to the operator whereby the volume of air is varied, thereby preventing the re-annealing of the face of the mold. The blast pressure is only sufficient to gradually cool the body of the roll, thereby eliminating casting strains. An absolutely uniform depth of chill is obtained, as shown in the group of rolls, Fig. 2. In addition, the face of the roll is also of a maximum hard-

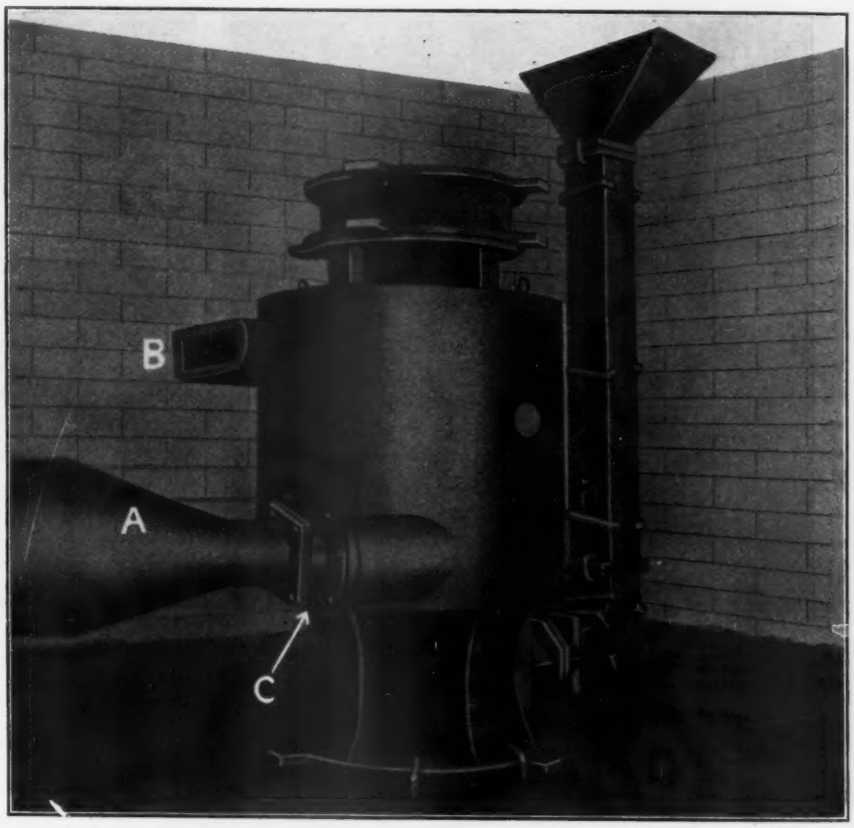

FIG. 1--THE ASSEMBLED MOLD FOR CASTING BLAST CHILLED SHEET AND TIN PLATE ROLLS; THE BLAST PIPE IS SHOWN AT *A*, AND *B* IS THE OPENING FOR THE EXHAUST

ness for the mixture employed, as there is no re-annealing effect which destroys the closeness of the grain. The blast pipe, *A*, Fig. 1, is direct-connected to a large blower capable of furnishing sufficient blast for several molds. The volume of air which regulates the rate of cooling is controlled by the gate valve, *C*. The temperature of the exhaust blast, when considered in conjunction with the pressure of the blast used, is an indication of the speed at which the roll is being cooled.

The section of the mold used as a chiller with its outer casing removed, is shown at *A*, Fig. 3. It will be noted that it is webbed throughout its length, thereby greatly increasing the radiating surface. The outer casing of the chiller is shown at *B*. It will be noted that this casing contains a number of spiral grooves, through which the blast must pass before reaching the rectangular opening, *C*, through which the blast exhausts. This insures a uniform distribution of the blast throughout the interior of the mold and produces a uniform rate of cooling. A group of sheet and tin plate rolls made by this process are illustrated in Fig. 2. The sinking head ends of the rolls are shown and the uniformity of the chills are unusual, particularly in view of the fact that on this end of the rolls the depth of chill generally lacks uniformity. The exclusive right to manufacture rolls by this process has been obtained by the National Roll & Foundry Co.

FIG. 2—GROUP OF SHEET AND TIN PLATE ROLLS, SHOWING UNIFORMITY IN DEPTH OF CHILLS ON SINKING HEAD ENDS

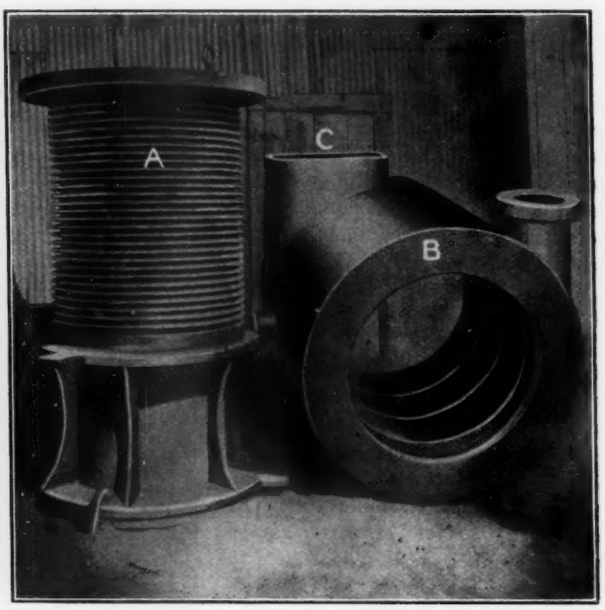

FIG. 3—CHILLER AND OUTER CASING OF MOLD FOR BLAST CHILLED ROLLS

Foundry Course of the Wentworth Institute

The Wentworth Institute, Boston, has established a one-year day course in foundry practice which is designed to teach foundry work to meet the requirements of modern manufacturing. The main building, which includes the foundry, is 145 x 49 feet, and five stories high, and the power house is 80 feet square. The aim of the new school is to impart to young men practical instruction which will enable them to enter industrial life from the time of graduation. The courses are designed for those who wish to become skilled and intelligent artisans and also for those who wish to prepare themselves for more responsible positions in mechanical and manufacturing plants.

The course in foundry practice is intended to familiarize the student with every phase of this work and covers all branches of molding and coremaking. The student is taught how to detect defects and remedies are suggested. The shop instruction includes bench and floor molding, experience with the different kinds of facing, open sand work and sweep and machine molding. The shop instruction is supplemented by a series of practical talks and lectures on materials used in the foundry, the selection of sand, the best method of venting, drying, handling of molds and cores and the operation of the cupola.

Wentworth Institute is so heavily endowed that the students are not required to pay any part of the expense of instruction. A nominal fee is only required to prevent the admission of those who might have no interest in their work.

Foundry Equipment Specifications

Specifications for foundry equipment for the West Technical high school, Cleveland, have been issued by the board of education of that city and will be received until noon, Oct. 16. All of the equipment must be delivered not later than Nov. 20. The foundry equipment specified, follows:

The cupola shall be a Whiting No. 1 or equal, 24 inches inside of lining with foundation and breeching complete. The height of stack from floor to top, 45 feet, and the charging door should be about 10 feet above the floor.

The tumbling mill shall be spur-geared with base and pulley complete. The tumbler shall be of the non-exhaust type and shall be of the Hill & Griffith type, 18 x 30 inches, or equal.

One Hill & Griffith portable core oven or equal is specified, the general dimensions providing for a height of 51 inches; width, 54 inches, and depth, 24 inches. The oven is to be arranged for natural gas.

The brass furnace shall be of the Monarch non-tilting, crucible type, for No. 40 crucible, or equal. The furnace shall be arranged for natural gas.

The blower is to do the work for both cupola and brass furnace and must

be of the proper size and speed to deliver 600 cubic feet of air per minute at 10 ounces pressure. A steel, No. 3 Sturtevant pressure blower or equal, operating at 3,600 revolutions per minute will be sufficient for this work.

Small foundry tools and equipment include the following: Thirty dry brushes, six camel hair brushes, six steel wire brushes, 36 riddles, 28 bench molders' bellows, 30 shovels, water pails, sprinkling cans, floor rammers, kerosene torches, mallets, 28 snap flasks, 28 galvanized iron slip boxes, sprue cutters, clamps, platform scale, six 40-pound hand ladles, tongs, crucibles, etc.

Drop Plate Molding Machine with Squeezer Attachment

A drop plate molding machine with squeezer attachment, which can be used in three different ways, and which practically combines the advantages of three molding machines in one, built by the Osborn Mfg. Co., Cleveland, is shown in the accompanying illustrations. The machine is similar in construction to the Osborn adjustable flask stripper and possesses all of its advantages. This machine has a uniform maximum pattern draw of six inches and is readily adjustable to a large range of flask sizes. The patterns are mounted on plates which drop directly from the flask, drawing both pattern and pins in

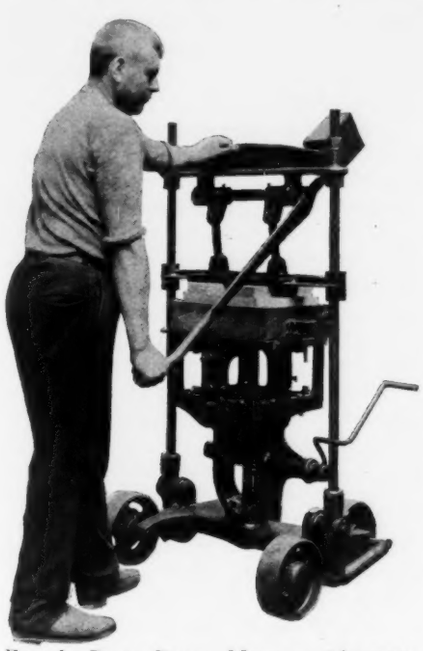

FIG. 1—DROP PLATE MOLDING MACHINE IN SQUEEZING POSITION

one operation. For many jobs this obviates the necessity of using individual stripping plates for each pattern. On the other hand, the machine is so constructed that stripping plates can be used when the work makes them necessary. The machine is mounted on a wheel base and is equipped with a powerful squeezer attachment.

The draw is accomplished by a half turn of the handle, the guides to the pattern carrier insuring accuracy. The

FIG. 2—DROP PLATE SQUEEZER WITH HEAD SWUNG BACK; COPE AND DRAG HALVES OF A MOLD AND PATTERN PLATE ARE SHOWN AT THE LEFT

squeezer attachment is simple in construction and the powerful leverage combined with a folding toggle which rolls the squeezing head directly upon the flask, provides sufficient pressure with only a small amount of effort on the part of the operator. The springs on the wheel base hold the squeezer attachment out of the way while the flask is being filled and also serves to counterbalance the squeezer head in its forward and backward movement. This drop plate squeezer is built with plain base as well as with a wheel base, shown in the illustrations. The portable machine can be readily moved from one floor to another. The wheels have extra wide rims which will not cut into the foundry floor, and are provided with enclosed, dust-proof bearings. This drop plate squeezer is made in two sizes, each of which can be furnished either with or without the wheel base. The larger of these two sizes takes flasks ranging from 13 to 16 inches in width and any length up to 21 inches, while the smaller machine takes flasks 9 to 12 inches in width and any length up to 21 inches. Inside flask dimensions are given in the foregoing, and both sizes of machines will admit flasks having a maximum length of 27 inches, outside. In each case the maximum pattern draw is six inches.

Protective Lead Coatings for Iron

Iron castings can be given a coating of lead as a protection against acids and other corrosive influences, if the iron is well galvanized and amalgamated with mercury previous to immersion in a lead bath. This is accomplished by cleaning the surface of the galvanized metal by dipping it in acidulated water, after which it is amalgamated by being thoroughly rubbed over with mercury contained in a closely woven cloth. The casting is then well dried and dipped in hot melted lead.

A recently patented solder for aluminum consists of a mixture of zinc, antimony and aluminum in the proportions of four ounces of zinc, one-fourth ounce of antimony and six drams of aluminum.

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Modern Foundry Practice

Every improvement that facilitates molding operations, all labor-saving appliances that reduce the cost of producing castings and each advance in foundry metallurgy are combined in the term—*modern foundry practice.* To those engaged directly in the manufacture of castings and to whom, only too frequently, the daily problems, seem almost insurmountable, the advance in foundry practice, recorded in the last decade, may seem unimportant. Yet, the changes that have been wrought are almost revolutionary and the methods of our forefathers have been discarded to enable us to keep pace with the rapid forward movement of industrial activity. While at first it would seem that the molding machine should be accorded a position in the front rank among the devices that have brought about this wonderful change in foundry practice, handling appliances should not be overlooked. Electric and pneumatic cranes, to a large extent, have replaced the hand-operated jib which formerly was considered the mark of distinction that elevated the modern casting plant above the backwoods shop. Hoists, both electric and pneumatic, are now the molders' helpers, and their services are always to be commanded promptly for rolling-over flasks, pouring molds, shaking-out, etc. Without the facilities afforded by the crane the large jar-ramming molding machine could not be considered a complete foundry tool, nor could smaller molding machines for large floor work boast such wonderful production records without the aid of the overhead traveler. The simple overhead trolley has likewise added its mite to the comforts of foundry operations, without considering its importance as a factor in increasing the dividends; and the lifting magnet, particularly in large shops, is a tool of all-work that can be used to advantage in the yard and in the shop. Industrial railway systems must also be accorded their share of credit for effecting great reductions in the rough labor costs. All these handling devices have made the work of the molder less arduous than in former years and his efficiency, particularly toward the end of the day, has been correspondingly increased. An overhead crane that commands the entire shop no longer is considered sufficient in the modern foundry, and the auxiliaries consist of hoists, wall and jib cranes, etc., that operate underneath the main traveler and are used to facilitate operations while the main crane is in use. In car wheel shops, hoists and trolleys have greatly relieved the molder who was formerly almost entirely dependent upon the slow, hand-operated jib crane for handling flasks and chillers and for rolling-over. The trusty wheelbarrow has almost been relegated to the scrap pile, as far as its usefulness for handling sand is concerned. There is an almost endless number of conveying systems that take care of the sand problem from the time of shaking-out to its delivery to the molder ready for use. It, therefore, becomes apparent from the foregoing, that handling appliances, in their range from the 100-ton overhead crane to the hand-operated trolley, have played an important part in revolutionizing foundry practice. The utilization of fuel oil is a latter-day development that is not without tremendous possibilities. Steel foundries operating open-hearth furnaces have found fuel oil more economical and as satisfactory as producer gas, and for heating core ovens its application is being rapidly extended. The fuel oil burner is a handy tool that can be used for various purposes throughout the shop, including the skin-drying of cores and molds, lighting cupolas, etc. The wood fire for lighting the coke bed has been dispensed with in many foundries and not only can the cupola be lighted in a much shorter time than formerly, but the cost in labor and material is only a fraction of that when using wood. Improvements that have made modern foundry practice possible and which have effected important economies are not necessarily among the spectacular changes that find the spot light; yet, while apparently playing a minor part their importance should not be overlooked, for in small things lies the genius of the great.

Trade Outlook

An improvement in foundry trade conditions was recorded in September, although all branches of the industry did not experience an increase in the demand for castings. Gray iron shops engaged in the manufacture of gas engine cylinders are operating at capacity and brass and aluminum foundries, specializing in automobile work, are hard pressed for deliveries. Gray iron jobbing shops likewise report the receipt of an increased tonnage, although operations are still far below normal. Malleable and steel foundries report a fair, scattering demand, although the railroad tonnage is light. Prices for castings reflect the low quotations that prevail in the iron market and in some instances business is being taken at prices which must entail losses to the fortunate or unfortunate recipients of the orders. Slightly lower pig iron values are prevailing and in the leading centers No. 2 foundry is quoted as follows: Northern, Chicago, $14.50; southern, Cincinnati, $13.25; southern, Birmingham, $10.00; Philadelphia, $15.00; Pittsburgh, $14.40; Cleveland, $13.75; Buffalo, $13.75; New York, $14.75; Lake Superior char-

coal, Chicago, $16.50. Non-ferrous metals are quoted in large lots, New York delivery, as follows: Copper, electrolytic, 12.375 cents, and lake, 12.60 cents; lead, 4.50 cents; spelter, 6.05 cents; antimony, Cookson's, 8.25 cents, and Hallett's, 7.75 cents.

Personal

J. Turner Moore, president of the Reading Steel Castings Co., Reading, Pa., has been elected treasurer of the Reading Steel Castings Relief Association. This organization, which was formed by the employes of this concern, plans to pay sickness and accident benefits.

W. Scott Thomas, who for the past 13 months has been in charge of the western branch of the J. W. Paxson Co., Detroit, has been appointed manager of the eastern branch of this concern with headquarters at Providence, R. I. Mr. Thomas will be assisted in the east by Wm. T. Nicholson.

Use of Timber on Jolt Machine Tables

To the *Editor:*

Noting your description of the use of yellow pine timbers on the tables of jolt-ramming machines to extend their length for molds longer than the tables of the machines, I wish to call attention to the serious fallacy involved in this often pernicious practice. There is no way to extend the effective ramming surface of a jolt-ramming machine beyond the impact surface on the anvil or bumper frame, except by enormously heavy, and, therefore, wasteful construction of machine tables and any attempt to increase the available length of a jolt ramming machine by the use of wooden timbers is worse than useless.

Let it be considered that the greatest intensity of pressure developed in jolt-ramming is directly under the edges of the heavy iron flasks employed on these large machines, and that static weights on jolt-ramming tables are multiplied from 50 to 100 times, according to the quality of the blow. With these facts in mind let the foundryman realize the effect of the edges of a flask weighing several tons driving down on wooden supports extending beyond the table limits. The center of the molding is relatively soft and plastic sand. At the edges all around is the iron flask. If the attempt is made to support this flask on wooden timbers extending beyond the edges of the table, such support will not only amount to practically nothing, but the timbers bending down over the edges of the table under the impact will spring up under the center of the match-board, often driving the joint hollow by actual buckling of the wooden board.

A little more reflection on the part of foundrymen will lead to a better understanding of the impracticability of doing more than getting into trouble by overhang of any sort in jolt-ramming operations. In cases of flask overhang the stiffness of the two sides of the flask which rest across the rigid impact surface of the jolt-ramming machine is all that can be depended upon to prevent whipping of the ends of the molds and the battens on the pattern board should be kept cut to the edges of the tables of the machine to obtain the full benefit from flask sides.

E. H. MUMFORD.

Book Review

The Principles of Scientific Management, by Frederick Winslow Taylor, 6 x 9 inches, 144 pages, published by Harper & Brothers, and supplied by THE FOUNDRY for $1.50.

This book explains the underlying principles of scientific management. The ultimate object of this method of handling labor, sometimes known as the Taylor system, is the attainment of a low labor cost in industrial production, and to accomplish this the natural or acquired movements of workers at their daily toil have been subjected to analysis with a view to the elimination of lost motion, as all movements not directly conducive to the accomplishment of the work might be termed. The average worker unconsciously and sometimes purposely employs many movements that are entirely superfluous, as far as expediting the work is concerned, and which often greatly extend the time required for its completion. The secret of the superior speed of some workers lies in the fact that they have learned to eliminate some of these motions.

Scientific management has reduced this elimination to a science, and its adoption results in greatly increasing the output of the worker. A man loading pig iron into a car under this system moves about four times as much material than can possibly be handled by other hand methods; a bricklayer will lay more than double the number of bricks he formerly laid in a day, and 35 girls inspecting steel balls for bearings, accomplish the same amount of work that 120 girls previously performed, and in less time. This almost startling increase in efficiency is obtained by the elimination of all false movements, and the worker is pushed to the utmost of his capacity. It is realized, however, that such strenuous exertion cannot be continued indefinitely without injury, and to prevent this, periods of rest are arranged at stated intervals before fatigue sets in, and which conserve the strength of the worker to the end of the day. In the case of the girls it is stated that after an hour and a half of continuous work, they begin to get nervous, consequently, the recreation periods were placed at intervals of one and a quarter hours, and lasted ten minutes, during which time the girls were encouraged to walk around, talk and relax as much as possible. The pig iron handlers rested after carrying 10 or 20 pigs of iron. To encourage the workers they are given extra compensation, and one of the principles of this system of management is that the compensation be generous, and once fixed should not be changed, as the cutting of prices, such as frequently occurs when operating on a piecework basis, is fatal to the success of the system.

A perusal of this work will show that the Taylor system has many good points to recommend it, but that it must be thoroughly understood before an attempt at installation is made; also that it must be applied in its entirety and not in part; that it is costly and tedious to install, but when in successful operation is productive of great economy.

Use of Oil as Fuel in Steel Foundries

The use of oil as fuel in steel works and steel foundries covers a wide geographical range. Open-hearth steel furnaces require not only a large quantity of oil per day, but an assurance of a continuous supply, as a shutdown of such a furnace entails a heavy loss. Fuel oil open-hearth furnaces are operated in Boston, Mass., Portland, Me., Londonderry, N. S., Seattle, Wash., San Francisco, Cal., St. Louis, Mo., Washington, D. C., as well as in the leading steel-making centers. Tate, Jones & Co., Inc., Pittsburgh, have equipped open-hearth furnaces with fuel oil burners, reversing stands, etc., in all of these cities and in addition, 75 open-hearth furnaces are thus equipped in such steel-making districts as Pittsburgh, Chicago, etc.

FOUNDRY and PATTERN SHOP EQUIPMENT

Combined squeezer and jar-ramming molding machine and plain squeezers--Portable molder's bench--Steel shop furniture--Riddle oscillator--Swinging grinder--Sectional flask--Duplex jarring machine

A PORTABLE molding machine for light work, in which the jolt-ramming and squeezing principles of making molds are combined, is now being built by the Arcade Mfg. Co., Freeport, Ill. This machine, shown in Figs. 1 and 2, can be used as a combined squeezer and jolt-rammer or as a simple squeezer for light work and as a jolt-ramming machine without the squeezer for comparatively heavy work.

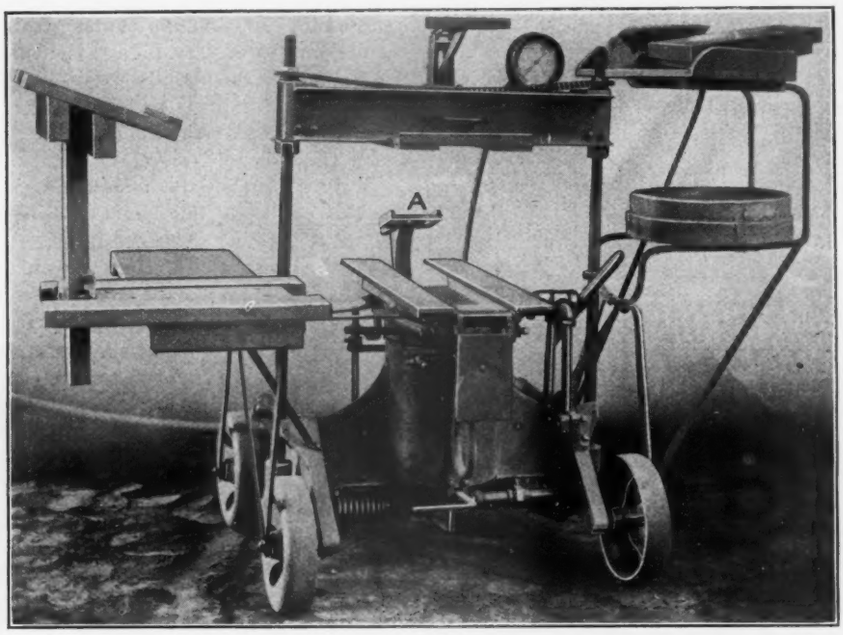


FIG. 1—COMBINED SQUEEZER AND JAR-RAMMING MOLDING MACHINE IN SQUEEZING POSITION

This machine in position for squeezing a mold, with the head swung forward, directly over the table, is illustrated in Fig. 1, while in Fig. 2 the head has been tilted back in position for jar-ramming the mold. The piston which serves to jar-ram the mold also squeezes the mold with its upward stroke when the head is in its forward position. When the head is thrown forward, the valve controlling the jolting mechanism is closed and the valve which actuates the squeezing movement is automatically opened. When making a mold in which the jolt-ramming and squeezing operations are employed, the flask, after being filled with sand, is jolt-rammed on the table of the machine, the squeezing head in the meantime being tilted back. After the mold has been jolt-rammed and struck-off, the squeezing board is adjusted, the head swung forward and the mold is squeezed. After lowering the piston, the head is tilted back and the pattern vibrator is set in motion by the knee pad at the front of the machine. When the knee pad is operated, the cope rest, shown at *A*, Fig. 1, is moved forward and the cope half of the mold is set on this rest while the pattern is being withdrawn from the mold. One of the novel features of this machine is the location of the vibrator in the cylinder. The head is provided with a chain adjustment which engages both nuts on the upper ends of the uprights supporting the head. When raising or lowering the head, these nuts are actuated by the chain and both are given the same number of turns, thereby insuring accurate head adjustment. The machine is provided with every convenience for the operator, being equipped with a stand for holding match-plates and bottom boards at the left and a riddle and tool rack at the right. The head is counterbalanced by a powerful spring to insure its easy backward and forward movement. The machine is portable, being mounted on four wheels, which have wide rims to prevent them from cutting into the foundry floor. This combination squeezer and jolt-ramming machine is built in two sizes with 10 and 14-inch cylinders.

A plain pneumatic squeezer, which rams the mold by an upward movement of the piston in the cylinder supported at the center of the machine frame, is shown in Figs. 3 and 4. An ingenious feature of this machine is the flask raising mechanism by which the cope and drag halves of the mold are lifted from the patterns. In Fig. 3, the machine is shown with the head swung back preparatory to filling the flasks

FIG. 2—COMBINED SQUEEZER AND JAR-RAMMING MACHINE IN POSITION FOR JAR-RAMMING A MOLD

with sand. After filling the flasks, the squeezing boards are adjusted, the head is swung forward and the two parts of the mold are rammed by the upward movement of the piston. The head is then swung back and the vibrator is set in motion by the knee pad at the front of the machine. At the same time the molds are raised away from the patterns by lifting a lever which raises a frame to which eight pins are attached which contact with the four corners of the parting lines of each flask. The drag half of the mold is then lifted from the machine and the cope is closed over, thus finishing the mold. At the left of the machine is a rack for bottom boards, match-plate and for resting the molds while they are being closed. At the right, the machine is provided with a shelf for tools and a steel support for the riddle. This machine, which is portable, being mounted on four wheels, is

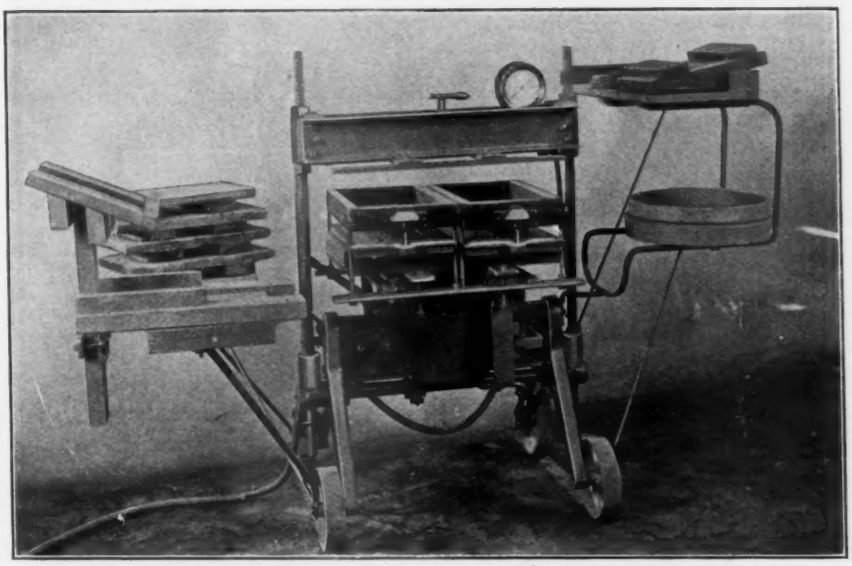


FIG. 4—POWER SQUEEZER SHOWING FLASKS RAISED AWAY FROM THE PATTERN

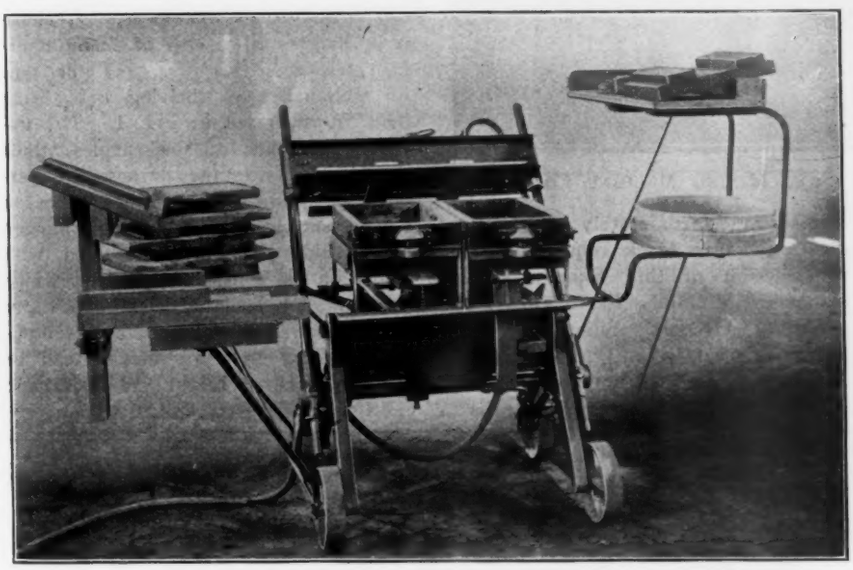


FIG. 3—POWER SQUEEZER WITH RAMMING HEAD SWUNG BACK

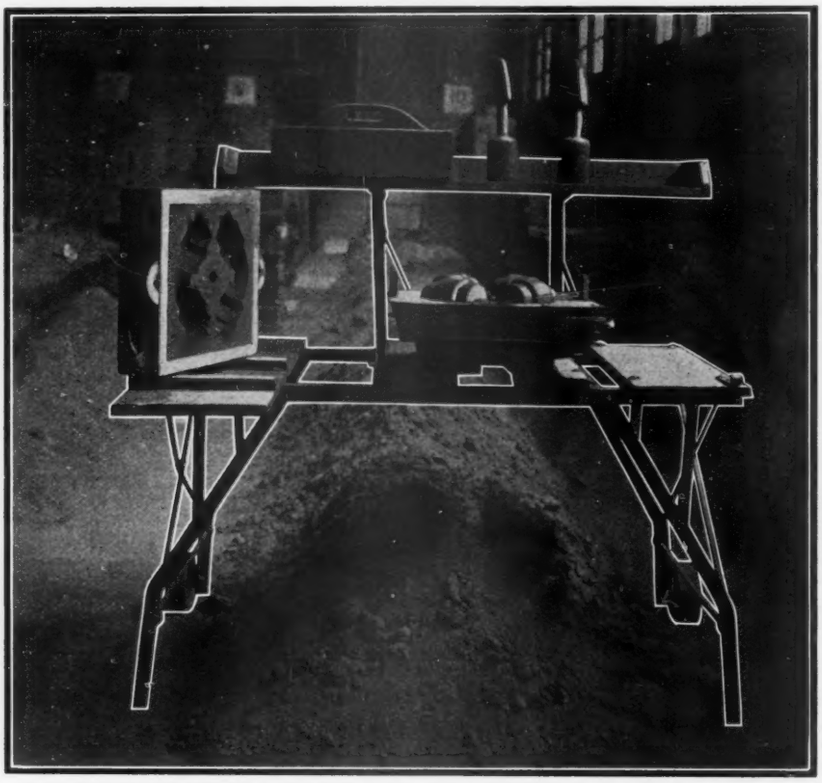
Bretaud Converters

J. V. Bretaud, foundry engineer and manufacturer of steel converters, 97 Jefferson street, Muskegon, Mich., has just completed the installation of a converter in the Dayton Steel Foundry Co.'s plant, Dayton, O. This converter is of the Bretaud type with a removable top and has capacity of two tons. This plant has been in successful operation since the first blow and although most of the castings made consist of automobile parts, the metal is so fluid that no difficulty is experienced in pouring off entire heats with bull ladles filled from the converter. The Dayton Steel Foundry Co. formerly made steel by the crucible process. A Bretaud converter is also being installed in the plant of the Muskegon Steel Casting Co., Muskegon, Mich. This converter has capacity of one ton.

built in two sizes with 10 and 14-inch cylinders.

In Fig. 5 is shown another type of plain power squeezer, built by the Arcade Mfg. Co., which is equipped with two air cylinders, mounted on the main shaft on either side of the machine. The squeezing of the mold is accomplished by a gear toggle movement, the presser head being lowered by the pistons of the air cylinders. This machine is equipped with a knee pad vibrator and a cope rest, on which the cope is set when drawing the pattern. The air pressure for ramming can be set at any desired point for making molds of different depths. The head is counterbalanced by a powerful spring to facilitate its forward and backward movement. The machine is intended for match-plate work and has a capacity for flasks, 44 inches long and 18 inches wide. This machine is portable, being mounted on four wheels.

FIG. 5—POWER SQUEEZER FOR MATCH-PLATE WORK, EQUIPPED WITH SIDE CYLINDERS



PORTABLE BENCH, BUILT BY THE SAND MIXING MACHINE CO.

A Portable Molder's Bench

A portable molder's bench, built by the Sand Mixing Machine Co., 220 Broadway, New York City, is shown in the accompanying illustration. The frame of the bench is made of 1½-inch steel angles which are thoroughly braced to insure rigidity. The height from the floor to the top of the molding table is about 27 inches, but it may be built up above the regular molding table to raise it to any height. The bench is 4 feet, 4 inches wide and is provided with a 10-inch shelf at the rear which is elevated above the table about 18 inches. This shelf extends the full length of the bench and can be used for holding cores, molder's tools, etc. At the left is shown a 12-inch shelf on the same level as the molding table on which one-half of the mold is set while the molder is drawing the pattern. At the right is a 10-inch shelf which can be used for tools, etc. The rear legs are mounted on cast iron wheels which are provided with wide rims to prevent the wheels from cutting into the foundry floor. The bench is extremely light and can readily be moved from floor to floor by one molder.

The Osceola Silica & Fire Brick Co., Oliver building, Pittsburgh, has closed a contract with the Pittsburgh Crucible Steel Co., Pittsburgh, for furnishing approximately one-half of the No. 1 fire brick required in the construction of this company's new plant at Midland, Pa. The plant of the Osceola Silica & Fire Brick Co. has recently been greatly improved at an expenditure of $30,000.

Steel Shop Furniture

In foundries, pattern storage buildings, machine shops and manufacturing plants generally, steel is supplanting wood in the construction of shelves, bins, racks, tool cabinets, etc. In addition to being fireproof, steel has many advantages over wood, and the sectional construction of shelving permits of its extension from time to time to meet the requirements for increased storage space. For the storage of cores, steel shelving is now being installed in many foundries and the adjustable feature of this equipment as well as its fireproof qualities, makes it particularly desirable for use in pattern storage buildings. In machine shops steel bins are used for the storage of castings and other small parts, while steel cabinets, provided with steel doors which can be locked, serve for the storage of tools, jigs, dies, etc.

The Cleveland Wire Spring Co., Cleveland, makes a specialty of manufacturing steel shop furniture and the type of sectional steel shelving now being built is illustrated in Fig. 1. The uprights are made of steel angles which are punched for the purpose of permitting the adjustment of the shelves on 3-inch centers. The shelves are flanged on all sides and are reinforced with angles on the ends. The shelves, which are built for loads of 200 pounds per square foot, are bolted to the steel uprights. This style of shelving can be built any desired height and width and

FIG. 1—SECTIONAL STEEL SHELVING, BUILT BY THE CLEVELAND WIRE SPRING CO.

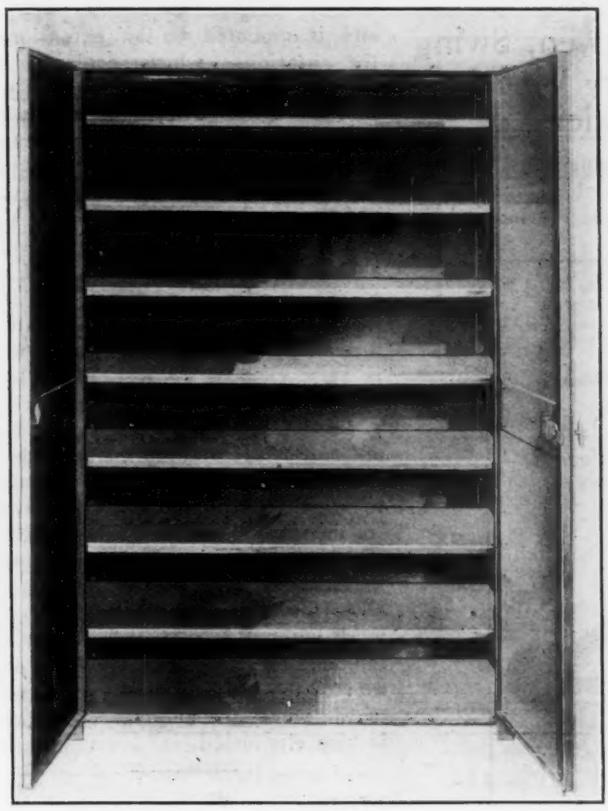


FIG. 2—SECTIONAL STEEL SHELVING, PROVIDED WITH DOORS FOR USE AS A CABINET

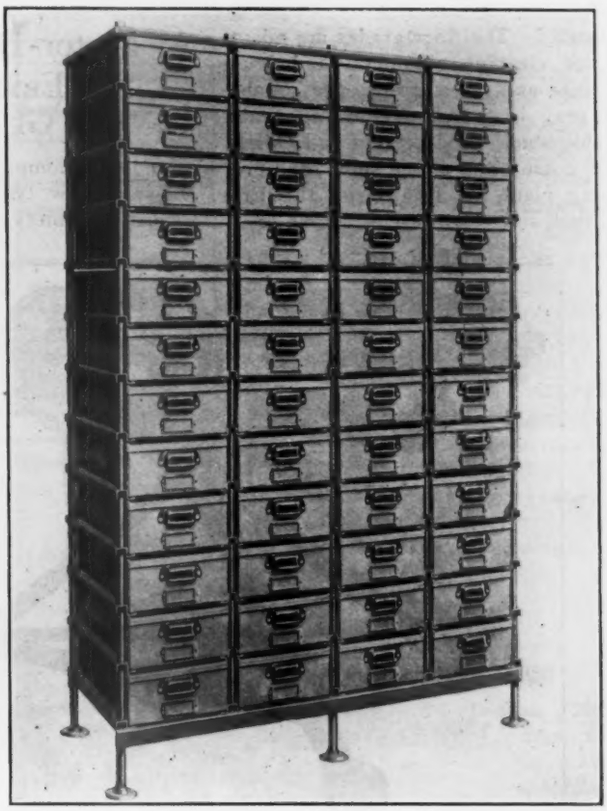


FIG. 3—ADJUSTABLE STEEL STORAGE RACK, EQUIPPED WITH DRAWERS

can be provided with backs and bin fronts as well as bin partitions for the storage of small parts, such as castings, screws, bolts, nuts, etc. Fig. 2 shows a section of this shelving equipped with steel doors, making a suitable cabinet for tools, dies, jigs, etc.

An adjustable steel storage rack, equipped with drawers and provided with card holders, is illustrated in Fig. 3. The rack consists of a steel skeleton frame and the end rods as well as those dividing the sections of drawers, carry the sections of pipe over which are set the channel steel sections which serve as slides for the drawers. Drawers of any length can be furnished and the only change in construction necessary is in the length of the section of pipe over which the steel slide is set. This storage rack can be built any height and with any number of sections. The upright rods are bolted to the top of the rack, thereby making the rack exceedingly rigid. The drawers are made of Nos. 16, 18 or 20 gage steel, according to the load to be carried and are of the reinforced, folded type of construction.

A steel stool for use in core shops, where wooden stools and benches have only a short period of usefulness, owing to heat and dry air, is shown in Fig. 4. The legs are made of steel angles and are adjustable to any height. To the tops of the steel angles is riveted a stamped steel ring, in which is placed a laminated wooden seat. This stool is also made with solid steel legs and can be furnished with a stamped steel seat. The seats of all the various types of stools built are 14 inches in diameter.

FIG. 4—ADJUSTABLE STEEL STOOL FOR CORE ROOM USE

New Source of Sand Blast Sand Supply

Sand-blasting operations are constantly being increased by new applications and the use of the sand blast is by no means limited to the cleaning of castings. Fabricators of structural material are installing these machines for cleaning sections before painting so as to insure a clean surface and to thereby further retard corrosion. Tank works and similar manufacturing establishments are likewise installing this equipment and with the growing use of this device there has been a correspondingly increased demand for sand blast sand. Heretofore much of this sand has been shipped from the east, where it is dredged from the Atlantic ocean. A large deposit of silica rock, which is unusually well adapted for sand-blasting purposes, has been uncovered in Portage county, O. This deposit is owned by the Portage Silica Co., Youngstown, O., and consists of practically 900 acres. The rock is now being mined by this concern and a large crushing and disintegrating plant, as well as washer and dryer have been installed, and, in addition to sand blast sand, this company furnishes silica sand for steel foundries for use as molding sand and silica wash and sand for furnace bottoms, etc. This sand is extremely pure and contains 98.98 per cent silica. The sand blast sand can be furnished in six grades adapted for various classes of work, the coarser grade being especially suitable for use in cleaning castings which are to be subsequently

enameled. The finer grades are adapted for cleaning aluminum and brass castings and other grades are suitable for gray iron and steel castings and rolled steel products of all kinds. The company's mines and sand-preparing plant are located on the Erie railroad and the present output averages from 400 to 500 tons daily. The dryer installation permits of the shipment of dry sand at any time of the year, thus precluding the necessity of foundries carrying a large stock of sand through the winter months.

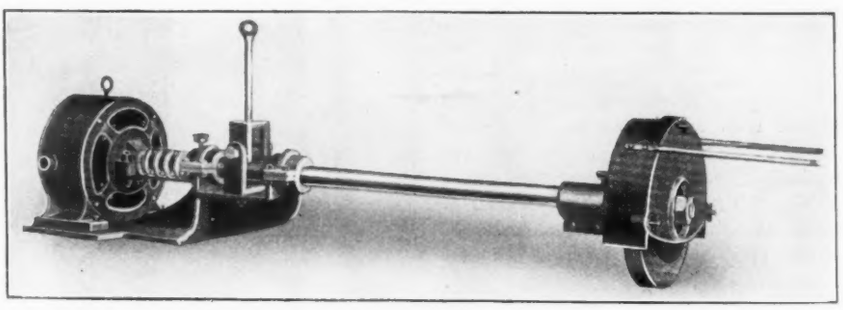
THE NEW HANNA RIDDLE OSCILLATOR

A New Riddle Oscillator

The accompanying illustration shows a new riddle oscillator recently placed on the market by the Hanna Engineering Works, Chicago. The action of this machine is different from that of most devices used for riddling sand and reproduces almost exactly the action of a molder screening sand by hand. The machine is equipped with a one-third-horsepower motor, and will screen all the sand which one man can shovel into the riddle. Its construction is such that at no point is there a dead center and consequently there is no danger from undue shock or overload on the motor. The screen holder is arranged to accommodate an ordinary 18-inch foundry riddle, and is provided with a quick-acting clamp to facilitate removal. The motor and gearing are protected by a housing which prevents the sand from being thrown into the working parts. With this machine it is claimed that the proportion of core sand to oil in core mixtures can be increased 50 per cent, obtaining a better mixture than is possible by hand.

A Motor-Driven, Swinging Emery Wheel Grinder

In the accompanying illustration is shown a new type of swinging, motor-driven, emery wheel grinder, built by the Pittsburgh Steel Foundry, Pittsburgh. This machine, which is known as the Hassel motor-driven, beltless, swinging emery wheel stand, possesses several interesting and novel features. It is suspended by means of an upright bar, attached to the frame of the machine, as shown. Through the eye of this bar a chain may be passed, the other end of which is fastened to an overhead beam or other support, permitting the machine to be held at any desired height from the ground. The emery wheel is encased in a shield of heavy cast steel, and is mounted on the end of a shaft which is balanced by a five-horsepower electric motor. The shaft is encased and passes through bearings carried by the frame of the machine underneath the point of suspension. The motor is dust-proof and is mounted on an extension of the bearings, which projects outwardly, underneath and in a line with the shaft. A 24-inch emery wheel is used, and two handles project from the hood of the wheel and by their means the operator is enabled to manipulate the wheel, moving it back and forth at will for a radius of about eight feet. The entire frame of the grinder is made of cast steel of heavy section, and the shaft is forged machinery steel. The grinder is very efficient because of its convenience, and will rapidly turn out a large amount of work, as there are no delays due to belt accidents, and also because of the severe usage to which it can be subjected, owing to the heavy shield over the wheel, which induces a sense of security in the mind of the operator, that enables him to apply the wheel to the work without fear of its breaking and inflicting personal injury. The position of the operator being at the side of the wheel the annoyance of sparks is also eliminated.



SWINGING, MOTOR-DRIVEN EMERY WHEEL GRINDER

Uniform Laboratory Report Cards

The American Brass Founders' Association and the American Foundrymen's Association have jointly appointed a committee to recommend and establish, if possible, uniform report cards dealing with the reports made by laboratories on metals and also on ores, coal and coke. At the present time a wide variety of cards is used and these are confusing when one concern receives reports from a number of different laboratories. It will be the effort of this committee to establish a report card that will meet all requirements, which will be simple, yet sufficiently comprehensive for the purpose for which it is intended. An effort will be made to co-operate with a similar committee from the Automobile Engineers' Society. The committee appointed by the American Brass Founders' Asso-

ciation follows: W. P. Putnam, Detroit Testing Laboratory, Detroit, chairman; W. M. Corse, Lumen Bearing Co., Buffalo, and Wm. Vaughan, A. D. Little, Inc., Boston. The American Foundrymen's Association committee is composed of W. P. Putnam, chairman; H. E. Diller, General Electric Co., Schenectady, N. Y., and Geo. C. Davis, Philadelphia.

An Improved Sectional Flask

A flask which embodies a number of novel features, is shown in Fig. 1. It is provided with the usual perforated end lugs for the insertion of steel guide pins which are threaded and are secured by nuts. The sections which compose the flask are interchangeable and may be assembled by clamps which engage lugs on the adjacent sides of the contiguous sections. The lugs have curved exterior surfaces, while the interior faces are flat, inclining toward each other and tapering toward one end. The clamps are C-shaped and have tapered clamping faces to correspond with the lugs. By the use of these clamps any number of sections may be assembled for any desired depth of cope or drag. The two lugs on one corner of each section may also be used as sockets in which specially designed handles may be fitted. The handle shown at *B*, Fig. 2, conforms to the taper of the lugs. After having been used in setting up the mold, the handles may be withdrawn from the lugs and the flask will then be without projecting arms. The flasks are made of cast steel or cast iron, as desired, and the sections subject to the greatest strains are reinforced with an extra thickness of metal. If wood flasks are employed the lugs, pins, clamps and handles can be furnished separately. For heavy work in foundries without cranes, handles of greater length may be furnished. These handles are made of steel, wrought iron or cast iron. This flask, with the various attachments, is manufactured by L. J. Kreutzberg, 147 South Ninth street, Easton, Pa.

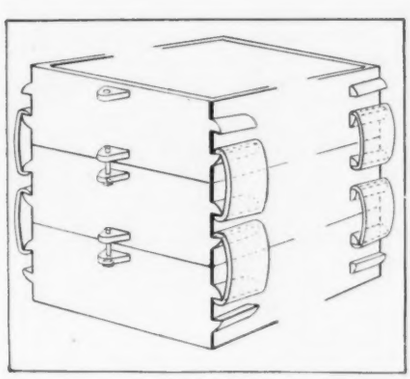


FIG. 1—A SECTIONAL FLASK, WHICH CONSISTS OF A ONE SECTION DRAG AND A TWO SECTION COPE

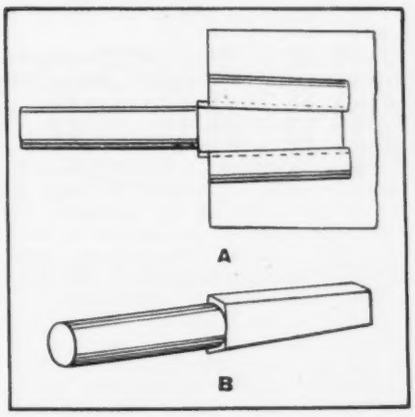
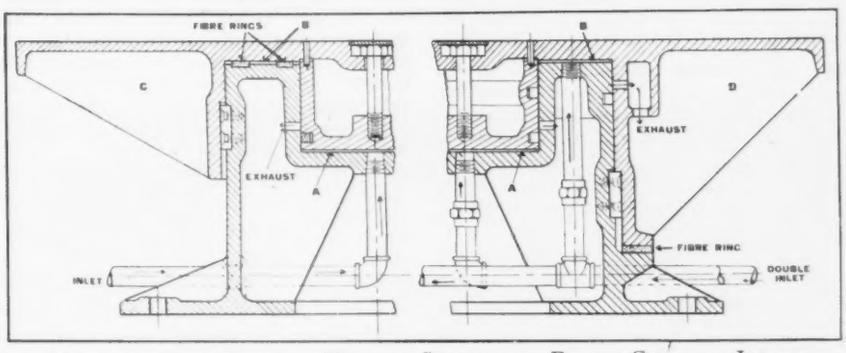


FIG. 2—METHOD OF INSERTING A HANDLE IN ONE OF THE LUGS IS SHOWN AT *A*; *B* IS THE HANDLE

Murphy Duplex Jarring Machine

A valveless jar-ramming machine of a new type designed and patented by James H. Murphy, Hamilton, O., is shown in the accompanying illustration. This machine is built with either one or a number of cylinders, the multiplicity of the latter being carried out in a simple and novel manner. To effect close economy, a cut-off valve can be attached to the base of the machine. This valve, which is shown, is operated automatically by an adjustable tapet attached to the side of the table slide. With some slight changes in design, the machine can be also equipped with a variable stroke valve having a variation from ¼ inch to 3 inches with one or all cylinders. This machine is particularly applicable for making molds of variable size and weight, inasmuch as the cylinders can be operated separately or in unison at the will of the operator, who is thus enabled to adjust the consumption of power to the demands of the load. Cylinder, *A*, for example, the diameter of which is 12 inches, with air at 80 pounds pressure, will approximately lift two tons, while the cylinder of machine, *D*, 20 inches diameter, will lift four tons. When the two cylinders are operated in unison the lifting capacity of the machine is six tons. Thus the lifting capacity of a two-cylinder machine can be varied through a range of two, four and six tons respectively. With the exception of the spring rings the machine practically consists of only two sections. Where only one cylinder is required the table slide can be shortened, and the jar or bump taken on two fiber rings fastened in cylinder, *B*.



HALF SECTIONS THROUGH MURPHY SINGLE AND DOUBLE-CYLINDER JARRING MACHINES

Trade Notes

The Mumford Molding Machine Co., Plainfield, N. J., manufacturer of a varied line of molding machines, has opened an office at 75 High street, Boston, with T. J. Mumford, 2nd, in charge.

The Norton Co., Worcester, Mass., has issued a handy calendar, covering a period of from July, 1911, to September, 1912. Each page covers three months, which makes the calendar very handy for reference purposes.

The Mumford Molding Machine Co., Plainfield, N. J., reports the receipt of an order for a number of jolt-ramming machines to be installed in the new foundry that is being erected by the General Electric Co. at Erie, Pa. Other jolt machine orders received include a 24-inch cylinder machine with table 72 inches square for the Burnside works of the American Brake Shoe & Foundry Co.; a third jolt-ramming machine for the Snow Steam Pump Works, Buffalo, and a jolt-ramming machine with a table, 72 x 108 inches, for the Moore & White Co., Philadelphia.

Trade Publications

FUEL OIL BURNERS FOR LIGHTING CUPOLAS.—In an eight-page bulletin issued by the Hauck Mfg. Co., 140 Cedar street, New York City, the application of fuel oil burners for lighting cupolas is described and numerous illustrations are given, showing not only the method of lighting cupolas, but drawings are included illustrating the arrangement of the coke bed to insure its lighting most economically and efficiently. It is claimed that the fire can be lighted at a maximum cost of 10 cents for oil consumption and in addition the smoke nuisance is entirely eliminated.

CINDER CRUSHERS.—The Eastern Machinery Co., New Haven, Conn., has issued a folder which contains a partial list of purchasers of Hill cinder crushers, which are especially adapted for pulverizing and cleaning brass foundry cinders, skimmings and material of a similar nature. This machine is built in two sizes, the smaller size being adapted for small brass foundries, laboratories, etc., where only a small amount of material is to be crushed and separated. These crushers are adapted for either the wet or dry process.

ELECTRIC LOCOMOTIVES.—Storage battery locomotives for industrial railways, built by the C. W. Hunt Co., New York City, are described in a 16-page booklet, issued by this concern. The standard gage for these locomotives is 21½ inches and it is claimed that this gage makes it possible to reach any part of the works as the locomotive runs with perfect freedom around curves of 12 feet radius. These locomotives are adapted for use in shops, foundries and other manufacturing plants where heavy material is to be moved on cars. The total weight of the locomotive is about five tons and it is carried by two trucks pivoted on the car body, the driving power being furnished by two series motors placed one at each end of the car on a raised platform. Power is transmitted to the axles through a reduction gear and a chain drive. A novel feature has been introduced by providing wheels with outside flanges. In turning a curve the outer wheels run on these flanges over a specially constructed rail.

REGENERATIVE FLAME LAMPS.—The Adams-Bagnall Electric Co., Cleveland, describes and illustrates regenerative flame lamps in a 16-page catalog, recently issued. The construction of the lamp is described in detail and instructions are given for trimming. The lamp is adapted for lighting large areas and for the general illumination of foundries, mills and industrial plants. The direct current multiple lamp is furnished for circuits of 100 to 130 volts with current adjustment of 5.5 amperes with 70 volts at the arc. The alternating current multiple lamp is furnished for circuits of 100 to 130 volts and 50 to 140 cycles with current adjustment of 7 amperes. The direct current, multiple series lamps are furnished for operation, two in series across 200-250 volts with current adjustment of 5.5 amperes and about 70 volts at the arc. A number of illustrations are included, showing the illumination of mills and factories with these lamps. A pamphlet, entitled "Abolites," is also being sent to the trade by the Adams-Bagnall Co., which illustrates and describes this concern's latest development for commerciel and industrial lighting with Mazda lamps.

General Industrial Notes

The Central Malleable Iron Co., Decatur, Ill., has changed its name to the Decatur Foundry Co.

The United Brass & Foundry Co., Detroit, has been incorporated with a capital of $10,000. The incorporators are Thos. Walburn, Mattie B. Walburn and Wm. Brabant.

The Columbus Castings Co., Detroit, has been incorporated with a capital of $30,000. The incorporators are Frank Illensberger, Thos. H. Sedley and Edward L. Nelson.

The Reliance Iron & Engine Co., Racine, Wis., has removed its plant to La Crosse, Wis., where it will be operated under the name of the Sta-Rite Engine Co.

The Roberts Foundry Co., Indianapolis, has been incorporated with a capital of $10,000 and will operate a foundry. The directors of the new concern are W. H. Roberts, Emerson Davis and Elmer F. Wetzel.

The Craig Foundry Co., Bucyrus, O., has been incorporated with a capital of $30,000. The incorporators are A. T. Dennis, H. C. Howland, Edson Scott, J. H. Shaw and W. J. Porter.

The Youngstown Sashweight & Foundry Co., Youngstown, has been incorporated with a capital of $15,000. The incorporators are A. O. Potts, F. A. Kaerscher, W. H. Woolf, J. S. Cross and F. W. Edwards.

The Steel Tank Co., Aurora, Ill., has been incorporated with a capital of $20,000 and will operate a foundry and machine shop. The incorporators are Richard Harrell, Chas. C. Chabut and O. P. Abell.

The Motor Foundry Co., Detroit, has been incorporated with a capital of $35,000 to engage in the manufacture of iron and steel castings. The incorporators are John H. James, Joseph A. Geyman and Arthur Webster.

The Rochester Steel Castings Co., Rochester, N. Y., has been incorporated with a capital of $50,000. The officers of the company are as follows: President, F. C. Kimmel; vice president, Wm. Deininger, treasmel; vice president, Wm. Deininger; treaseral manager, I. C. Emery.

The Western Steel Foundries Co., Denver, Colo., recently incorporated with a capital of $400,000, has purchased the Colorado Gray Iron Works and will engage in the manufacture of steel castings for repairing locomotives, etc. The officers of the company are W. H. Kistler, president: R. M. Cash, vice president; E. Bracht, secretary, J. C. Burger, treasurer, and C. F. Springer, manager.

The firm name of Bowes, Jamieson & Co., Hamilton, Ont., Can., manufacturers of stoves and ranges, has been changed to Bowes, Jamieson, Ltd., and J. R. and J. W. Jamieson, sons of the former proprietor, will have charge of the active management of the business. The company is capitalized at $100,000. Shortly after Jan. 1 the company will enlarge its plant and the general arrangement of the foundry will be changed and the tonnage will be increased from seven to 10 tons per day. Molding machines will be installed and some work will be mounted on match-plates. The company is in the market for a set of patterns for a medium-priced line of warm air furnaces.

New Construction.

The Stacey Mfg. Co., Elwood, Cincinnati, O., will erect a new foundry, 214 x 50 feet.

The Emmert Mfg. Co., Waynesboro, Pa., is enlarging its foundry by an addition, 40 x 45 feet.

The R. Howe Printing Press Co., New York City, will erect a new plant near Easton, Pa.

The Packard Motor Car Co., Detroit, is erecting an addition to its foundry, 50 x 125 feet.

The Lamb Knitting Machine Co., Chicopee Falls, Mass., is contemplating the erection of a five-story brick building, 50 x 100 feet, and a two-story foundry, 60 x 168 feet.

The John A. McKay Co., Dunn, N. C., is erecting an addition to its machine shop, 40 x 140 feet, with two 40-foot wings, two stories high, and an addition to its foundry, 30 x 125 feet, with one 30-foot wing.

The Moran Co., Seattle, is planning to erect a new gray iron foundry, 100 x 200 feet, to be built adjacent to the company's present foundry. A 15-ton crane will be installed.

The Ferro Machine & Foundry Co., Cleveland, is erecting a steel and concrete foundry, 75 x 275 feet, and a pattern storage building, 60 x 75 feet. The foundry will be equipped with modern conveying machinery for sand and metal.

The Emmert Mfg. Co., Waynesboro, Pa., manufacturer of patternmakers' and woodworkers' vises, etc., will erect a 40 x 45-foot addition to its foundry and an air compressor plant will be installed. Pneumatic chippers and other cleaning equipment will also be added to the cleaning department.

The Elkins Foundry & Machine Co., Elkins, W. Va., will erect a foundry, 32 x 60 feet, in addition to a machine shop and other buildings. The officers of the company are C. S. Robb, president; N. I. Hall, vice president; R. B. Isner, secretary, and J. P. Phillips, manager.

The Iron City Foundry Co., Lebanon, Pa., will erect a large plant on the west side of Fourth street. The main foundry building will be 40 x 120 feet, and other buildings, including a storage building, will be erected adjacent to the foundry.

The Cadillac Motor Car Co., Detroit, a subsidiary of the General Motors Co., will erect several additions to its plant, including an addition to the iron foundry, a new brass foundry, and a three-story manufacturing building.

The Worcester Pressed Steel Co., Worcester, Mass., has recently added a foundry, 40 x 30 feet, to its plant, and will install a cupola, blower and other equipment necessary for the manufacture of castings. The officers of the company are Milton P. Higgins, president; John W. Higgins, secretary and general manager, and Geo. Alden, treasurer.

Among the Brass Founders.

J. W. Buckley, a foundryman of wide experience, is erecting a plant at Dalton, Mass., for the manufacture of brass, bronze and aluminum castings.

The Hawkins Pump Works, Downer's Grove, Ill., is erecting a brass foundry, 12 x 24 feet, which will be used for the manufacture of castings for its own factory.